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A journal of stomatology; devoted to the advancement and dissemination of knowledge pertaining to the teeth and mouth, and to their relations to the body as a whole

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Important Books Received

Textbook of physiology. By William D. Zoethout, Ph.D., Professor of Physiology, Chicago College of Dental Surgery, Loyola University. *Second edition.* 1925: pp. 616; 6¾ x 4 in.; 186 illustrations, $4.50. C. V. Mosby Co., St. Louis.

Physiological Chemistry; textbook and manual for students. By Albert P. Mathews, Ph.D., Professor of Biochemistry, University of Cincinnati. *Fourth edition.* 1925: pp. 1233; 7¼ x 4½; 109 illustrations; $6.50. William Wood and Co., New York City.

Bacterial infection, with special reference to dental practice. By J. L. T. Appleton, Jr., B.S., D.D.S., Professor of Microbiology and Bacteriopathology, Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania. 1925: pp. 474; 7¼ x 4 in.; 96 illustrations; $6.00. Lea and Febiger, Philadelphia.

Physical chemistry in biology and medicine. By J. F. McClendon, Ph.D., Professor of Physiologic Chemistry, and Grace Medes, Ph.D., Assistant Professor of Physiologic Chemistry, Medical School, University of Minnesota (Minneapolis). 1925: pp. 425: 6¾ x 4 in.; 34 illustrations; $4.50. W. B. Saunders Co., Philadelphia and London.

Dental materia medica and therapeutics, with special reference to the rational application of remedial measures to dental diseases. By Hermann Prinz, A.M., D.D.S., M.D., Sc.D., Professor of Materia Medica and Therapeutics, Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania. *Sixth edition.* 1926: pp. 632; 7 x 4½ in.; 146 illustrations; $6.00. C. V. Mosby Co., St. Louis.

Technic of oral radiography. By Clarence O. Simpson, M.D., D.D.S., F.A.C.D. 1926: pp. 207; 6¾ x 4 inches; 165 illustrations; $5.00. C. V. Mosby Co., St. Louis.

Orthodontics: an historical review of its origin and evolution. *Two volumes.* By Bernhard Wolf Weinberger, D.D.S., Librarian of First District Dental Society of the State of New York, and Advisory Librarian, Dental Department, New York Academy of Medicine, New York City. 1926: pp. 1011; 7¾ x 4¾ in.; 599 illustrations; $25.00 (*two volumes*). C. V. Mosby Co., St. Louis.

A textbook of exodontia—exodontia, oral surgery, and anesthesia. Leo Winter, D.D.S., Professor of Oral Surgery, College of Dentistry, New York University. 1927: pp. 364; 7¾ x 4½ in.; 329 illustrations; $7.50. C. V. Mosby Co., St. Louis

Harelip and cleft palate (cheiloschisis, uranoschisis, and staphyloschisis). By Matthew N. Federspiel, B.Sc., D.D.S., M.D., F.A.C.S., Professor of Oral Surgery, Marquette University. 1927: pp. 200; 6¾ x 4 in.; 156 illustrations; $5.00. C. V. Mosby Co., St. Louis.

A text-book of bacteriology for dental students. By Arthur Bulleid, L.R.C.P. (London), M.R.C.S., L.D.S. (England), Assistant Dental Surgeon and Assistant Bacteriologist, Guy's Hospital, London. 1927: pp. 219; 6¾ x 4 in.; 60 illustrations; $4.50. C. V. Mosby Co., St. Louis.

Textbook of biological chemistry. By James B. Sumner, Ph.D., Assistant Professor of Biological Chemistry, Cornell University (Ithaca). 1927: pp. 283; 6¾ x 4 in.; 6 illustrations; $3.50. MacMillan Co., New York City.

American text-book of operative dentistry. By Marcus L. Ward, D.D.S., D.D.Sc., F.A.C.D., Editor; Professor of Dental Metallurgy and Crown and Bridge Work, and Dean, College of Dental Surgery, University of Michigan. *Sixth edition.* 1926; pp. 818; 7¾ x 4¾ in.; 783 illustrations; $10.00. Lea and Febiger, Philadelphia and New York.

Annuario Dental 1926. By Salvador de Casas (and numerous collaborators). *Fifth edition.* 1926: pp. 462; 6¾ x 4¾ in.; nearly 200 illustrations; 12 Pesetas. Salvador de Casas, Calle de Galileo, No. 5, Madrid, Spain.

Dental education in the United States and Canada. By William J. Gies, M.S., Ph.D., Sc.D., LL.D., F.A.C.D., Professor of Biological Chemistry, Columbia University; Executive officer of the Board of Editors, *Journal of Dental Research;* with a preface by Henry S. Pritchett, Ph.D., Sc.D., LL.D., Litt.D., President of the Carnegie Foundation for the Advancement of Teaching. 1926 (issued in 1927): pp. 692; 7¼ x 5 in.; one illustration; distributed free of charge on application, by letter or in person. Carnegie Foundation for the Advancement of Teaching (the volume is "Bulletin No. Nineteen"), 522 Fifth Avenue, New York City.

RETAINERS IN PARTIAL PROSTHESIS[1]

HENRY W. GILLETT, D.M.D., F.A.C.D.

New York City

In order to establish a basis for comparison for the device to which I wish to call your attention, it is desirable that we should consider the qualities and efficiency of several of the devices in common use. The present pronounced vogue of the split retainer, intended for use within the normal outlines of vital teeth, leads me to consider that device first in the effort to evaluate properties and qualities of the various retainers. The profession has long been familar with different forms of retainers involving the principle of a divided male element internally placed with regard to a female element or sleeve, the latter usually rigidly fixed within a tooth. The early examples, which have more or less withstood the test of time, are the split pin and tube of the Peeso Bridge, the split bar and casing devised by Ash, and the split ball and tube by Roach.

All these are more commonly used in pulpless teeth than in vital ones. This fact eliminates the need for certain critical considerations that I shall emphasize with regard to retainers employing the same principle, but specifically intended and claimed to be safe for use in vital teeth. One distinction between these two classes that we may briefly make, in passing, is that the device for use in pulpless teeth may safely be made larger and consequently stronger than the one for use in vital teeth, because increase in size in the latter class beyond a fixed maximum immediately invites pulp complications. I think there is no question that, in the earlier days of removable bridgework, pulps were frequently removed solely to provide adequate space for the larger devices. Realization of the weighty objections to such a procedure is probably so general at present that it can happen only

[1] Read at a meeting of the First District Dental Society of the State of New York, at the New York Academy of Medicine, March 7, 1927.

under exceptional circumstances in the offices of responsible practitioners.

The efficiency of these retainers when used in pulpless teeth, the objectionable features of most of the clasp devices in common use, and the lack of understanding of the principles fundamental to the type of clasp that seems to have broad applicability and superior merit, very naturally and properly led to search for ways and means to utilize the same principles in vital teeth, once the profession became acutely conscious of the great risks necessarily attending the removal of pulps. Unfortunately, the problem presented an almost irreconcilable conflict between two important requirements. On the one hand, there was the need for adequate bulk to resist the thrust of the jaw muscles; on the other, a need for reducing the size of the retainer to the minimum because of probable encroachment upon the pulp. In the estimation of the writer, insufficient attention has been given to this second factor, for reasons that are not difficult to discover. The search for such retainers has been running parallel with, and has been greatly influenced by, the development of the casting process given us by Taggart in 1907. Certain natural influences, which I propose to treat of at length at another time and place, have served largely to eliminate, from the consciousness of those who have conceived retainers intended to be internally placed in vital teeth, the hazards of over-close relations between cast inlays and the sensitive elements of the teeth. The unfortunate demand for the same relations, between the cast inlay and the interior cavity-walls as those presented by the ideal foil filling, ran parallel with needs of the bridgeworker desiring to use a retainer that would tend to dislodge the inlay in which it was to be included. The dictum that the inlay must have frictional contact with the cavity walls tended to blind the operator to the risks he ran when he placed the cast casing of the metal sleeve of such a retainer close to the pulp of the tooth. He would naturally select the largest possible retainer for the case in hand, in order to insure mechanical strength, but this involved its placement close to the pulp of the tooth at the level of the cervical floor, this being frequently in a freshly cut or freshly enlarged cavity. Too little thought was given, under such circumstances, to the need for a considerable wall of dentine between the inlay and the pulp; or, in the case where the dentine

was insufficient for an equivalent layer of material of low thermal conductivity, such as the cements commonly used for the retention of inlays.

Before leaving this division of our subject, I wish to call to your attention the value of the references just made to freshly cut, or freshly enlarged cavities. You are all familar with the conditions existing under fillings that have been in place for a long period—the eburnation of a considerable layer of dentine next to the filling material, and the recession of the pulp, with the interposition of secondary dentine or the pulp-chamber wall next to the filling. You are familar with the fact that such pulps have departed in considerable degree from the normal, but often continue to function fairly well, if they do not receive sudden or increased shock disturbance. You are also familar with the fact that when the eburnated layer of underlying dentine is penetrated, you frequently find a high degree of sensitiveness. When much cutting is extended into this area, you know that you are apt to get rather prompt shock reaction from the pulp. Those of you with long experience and good powers of observation have learned that these abnormal pulps are easily pushed over the line dividing them from pathological pulps. We have here facts to be applied directly to our bridgework technic. If the cavity in a previously filled tooth, when it has been cleansed of old filling and decayed dentine, is of the right size and shape to receive the sleeve of the attachment it is desired to use in it, this may commonly be done without risk. But if fresh cutting beyond the layer of eburnated dentine is called for, in order to obtain room for the desired casting, then men of experience hesitate and search for some plan that will enable them to avoid the need for risking immediate shock as a result of mechanical interference—and also risking the subsequent chronic exhibition of thermal shock as a result of too close approach of metal to the freshly cut sensitive area.

With all the advocacy of retaining devices for use within the outlines of vital teeth, accompanied by emphatic warning of the risks attendant upon and the great objections to the removal of pulps, there has been a surprising failure adequately to estimate the hazards of the operations frequently recommended by the advocates of such retainers. Seizing upon the very real objections to clasps as they have

been commonly used, and failing to apply adequate analysis and ingenuity to the problem of eliminating their undesirable features, these deficiencies have been used as a buttress for a defence of what seems to many of us an indefensible practice; viz., that of cutting into sound, or nearly sound, teeth, cavities of sufficient width and depth to accommodate the sleeves of the retainers. In sound teeth, or teeth with only shallow cavities, we have a set of conditions entirely different from those presented by teeth having deep caries or secondary dentine: a pulp approximately normal in size and condition to the age of the patient, and consequently highly susceptible to shock. These factors should be weighed with the greatest care before deciding to insert into such a tooth a mass of metal large enough to include the sleeve of a split attachment together with the gold incidental to its retention, which must necessarily be large in proportion to the space available. In many teeth where no influence tending to increase the normal rate of pulp-chamber calcification has been operative, the size of pulp at the cervical floor is such that adequate space for the sleeve is difficult to obtain without approaching unduly close to the pulp. The sleeve ordinarily needs to be as long as the tooth will permit, and it consequently extends into the area where the thickness of the wall of dentine between the pulp and the tooth surface is rapidly growing less. Under these conditions, we have a pulp first exposed to a considerable degree of shock by the mechanical steps of cavity preparation, further exposed to steady chronic shock as the result of the insertion of the inlay, and frequently exposed to some degree of overstress as a result of the demands made upon the tooth in supporting the new bridge.

The pulp, of course, immediately sets up protective measures and commonly succeeds in protecting itself as regards the immediate future, but there is always risk that these activities will need to be so vigorous as to result in harmful deposits as well as a deposit of the beneficent protecting layer. Those who endorse this practice state that complications seldom result from this cause, and I am not inclined to question their statements as regards immediate serious results, because it is only the operators who are confident that their technic has been such as will enable them to defend it, who venture to do so. In my estimation, a much more important factor is the question of reactions that come about so slowly that they are not commonly con-

nected with the operation, and it is on this situation that I desire to lay emphasis, and in this connection to especially urge caution upon the young practitioner. I hold that the responsibility for the death of a pulp in a sound tooth, or one with only a small cavity in which an operator has cut a large cavity solely for the reception of a bridgework attachment, is the same whether it occurs ten days, ten weeks, or ten years after the operation. If this be granted, then he is equally responsible for the chronic invalidism or the death of his patient, if it happens to occur because of metastatic infections which will, in some percentage of cases, follow pulp death. This is a responsibility of which we need to be constantly reminded, because complications occurring several years later are seldom connected with the original cause. None of us would like to be caught clubbing a man in a dark alley, but this lane up which we lead our patients in bridgework is metaphorically a dark alley to them, and I feel that practitioners who endorse pulp removal, and wide and deep cutting in vital teeth, for any kind of bridge anchorage, when other measures equally effective are available, risk being charged with equally reprehensible conduct.

Before I leave this branch of our subject, I want to refer briefly to a related factor which I consider of importance. The claim has been made that our ordinary cements do not differ much from gold in the property of thermal conductivity. At this time, I cannot take up with you the actual situation except very briefly; but, even if we had time, it would be inadvisable because there still remains considerable work to be done in order to present the story adequately. We have gone far enough, however, to permit the statement that the thermal conductivity of cement is about 1/600th of that of gold, that the conductivity of the gold alloys commonly used for inlays is less than that of pure gold, but still several hundred times that of cement. This has an important bearing on all inlay practice. It has been conclusively demonstrated by long clinical tests that, for the ordinary inlay intended to serve only as one element of a compound filling, there is no need whatever for the "glove-like fit" or the "driving fit" which has been urged upon us. Consequently, in that field, we are free to use an adequate amount of cement between the inlay and all sensitive cavity walls. In the bridgework field, the influence of this fact I conceive to be something like this: It is probably a fact that the bridge

worker does need frictional contact between his cast inlay and the cavity walls whenever he is going to use attachments that tend to dislodge the casting. The fact that he is thus blocked from using an appreciable layer of cement between gold and dentine should lead him to consider with great care whether he is willing to take the responsibility of cutting deeply into a tooth and placing his gold in close contact with sensitive areas. He should also consider whether, in placing a "three-quarter crown," he is willing to strip the enamel from two-thirds or three-quarters of a sound tooth for the sake of making equally close contact, this contact being supplemented, as he frequently claims, by mechanical compression of dentine that is vital and often sensitive. These things should be carefully weighed when other measures, unaccompanied by any serious risks, are readily available and promise equally or even more satisfactory ultimate results.

In the past the training for our work has been so strongly concentrated upon its mechanical side that we are obliged to make large allowances for those of our number who seem to be unable to grasp the fact that mechanical perfection should be subordinated to the attainment of a superior degree of health service. But while we of the profession may be able to make these allowances, the public, which is rapidly becoming educated, will be less lenient with the man who exposes his patients to needless risk. In my estimation the fact that the design proposed for a prosthetic restoration calls for the insertion of a large inlay in close contact with sensitive dentine, or closely approaching the pulp, or that it calls for the stripping of the enamel from half to three-quarters of an essentially sound tooth, and replacement of it with metal should usually debar that design from further consideration.

Let us now turn to the field of clasps in which must be found relief from the risks I have pointed out, if it is to be found at all, so far as our present knowledge indicates. The wrought clasp is familar to all of you in its several different forms. You all know that the flat wrought-clasp is unsatisfactory because it commonly does not fit the tooth well enough and consequently acts as a food trap—that it involves stagnation of fluids between it and the tooth, accompanied by accumulation of sordes on the clasp itself, with consequent enamel decalcification. You are familar with the fact that such clasps can

be made to fit the tooth much better than they do in common practice, but that technicians capable of so making them are rare. You also know that when this improved fit has been attained it adds little to the value of the clasp as a retainer, and does not in any degree serve to remove the hazard of enamel decalcification due to stagnation of oral liquids. Next we have the wrought clasp made of half-round wire, a little better because it covers less of the tooth enamel, but still markedly inferior in this respect to the clasp made of round wire, which is so much easier to make, so much more adaptable, and covers the least possible area of enamel.

The inefficiencies and deficiencies of the flat wrought-clasp led Dr. Nesbett to devise the cast clasp with its greater and very tempting efficiency both as regards retention and capacity for thrust resistance, but unfortunately accompanied by a degree of destructiveness rendering it all but unusable by the practitioner having regard for the welfare of his patients. Its greater width as commonly used and its closer contact render more certain the retention of mouth fluids with their food and bacterial content in close contact with the enamel. I have good authority for the statement that stagnation of liquid under an uncemented orthodontic band may induce visible enamel decalcification in a period as short as twenty-four hours, and I regard this as conclusive evidence that any such clasps as those I will show you on the screen, which are taken from the advertisements of technicians who claim to render exceptional service to the profession, are highly undesirable.

While recent developments appear to have led to recognition of need for elimination of some of the excesses in size and mass of cast clasps, there has sprung up a vogue for a casting technic in the prosthetic field which disregards all known principles as regards volumetric changes in metals, waxes, and investments, due to changing temperatures and chemical reactions; and complex pieces, including cast clasps somewhat reduced in size, are produced at a single casting. If we may accept the advertisements of the technical laboratories as an indicator, history is repeating itself, and a wave of indiscriminate use of this mechanical absurdity is sweeping through our ranks.

Neither the cast nor the wrought clasps of any type attain what

is claimed for them by their more enthusiastic advocates; viz., contact with the whole surface of the tooth underlying them. Study of the inner surface of the clasps with a magnifying glass, on the next twenty pieces that come to your attention, will convince you that they make contact only in spots dotted here and there over their inner surface. A little reflection will convince you that this must necessarily be the case. The round-wire wrought clasp accompanied by adequate stabilization elements, reduces to the minimum the undesirable features of clasps and entirely eliminates the need for deep penetration into vital teeth, or any extreme stripping of enamel from them, in the effort to improve the security and stability of a prosthetic piece. In this combination it provides all the security necessary. It is adaptable to practically every type of case met with in practice, without violation of esthetic principles and with as much comfort for the patient as it is possible to obtain with any device now known. These desirable possibilities are growing easier of attainment because of the fact that some of our manufacturers of dental golds are coming to appreciate the demand in this field for a quality of gold alloys which will meet the technic requirements, including a high degree of response to heat treatment and high elasticity values, accompanied by the all-important feature of adequate metallurgical manufacturing technic to insure consistent duplication of standard qualities in successive lots. This last factor is just as important as the others named, and in the past, its absence has been the cause of much dissatisfaction for many practitioners. (There seems to be some evidence that the technic of production of dental golds by the manufacturer is scarcely more standardized than that of our dental laboratories.)

With the round-wire clasp, some effective means of stabilization to prevent vertical shifting of the piece is necessary in order to avoid the wearing of grooves in the narrow areas in which the clasps make contact. Cases where the clasps may rest against metal or porcelain afford the only escape from this requirement. There are exceptions to which I will refer later. The stabilization elements devised in principle by W. G. A. Bonwill, and reported in 1890, may take the form of occlusal rests, but preferably that of lugs seated in recesses of definite shape in the body of inlays or fillings in the teeth adjoining those supplied by the artificial appliance. These serve to support the

piece against the thrust of the jaw muscles, and to control tendency to lateral sway, and also to provide the opposing resistance to the clasp in cases where there is esthetic demand that its buccal half be omitted. The same principle is useful where malposition of teeth dictate the omission of either half of the clasp in order to obviate the need to introduce stress breakers, which might otherwise be required to permit insertion of the finished piece without undue stress upon the clasped teeth. Such lugs can easily be so designed as effectually to counteract any tendency towards tooth movement by clasps of this type.

Lest there should be a hasty conclusion that I am forgetting the hazards I have pointed out with regard to deep seated inlays, and recommending a course in which the same hazards exist, it is desirable to remind you that in most cases in which such restorations are indicated, there are tooth cavities on the surfaces adjoining the space to be filled, or fillings that may properly be replaced with others. The difference between the inlays required to carry these lug seats, and those for frictional attachments is this: the sleeves for the frictional attachments are of a predetermined size and shape, for which room must always be found regardless of the condition of the particular tooth involved; and they always require a considerable depth of cavity at the level of the cervical floor. On the other hand, the stabilizing lugs we are now talking about may be of any shape, lending themselves to the cavity forms most desirable for the involved teeth, provided they have a total cross sectional area adequate for the stress they will be required to meet. Moreover, they need never involve additional cavity depth in the cervical region because they need never extend into this region.

Most of the clasp wire available in past years has been of a quality inadequate and unreliable for this work. Other than for a small number of manufacturers, the product has lacked uniformity, and has very steadily presented one of two fatal defects: either it has been so soft as to have no adequate resiliency, or else it has been so poorly managed in the alloying process as to be brittle and consequently unreliable. And with both of these conditions, a third defect may have crept in due to improper handling of the wire at the time of drawing it. The joint work of the U. S. Bureau of Standards and the Weinstein Research Laboratory is bringing about a clearer under-

standing of these factors, and we shall eventually arrive at a clear-cut knowledge of formulae required for any particular service. Our manufacturers will have determined the technic necessary to obtain a uniform product, and we shall be able to apply definite and standardized tests to the product delivered. I am told that this work at the Bureau of Standards has been viciously attacked by a few dentists and by manufacturers, both as to reliability and as to its being accessible to all who desire to use the information. It is a privilege to say that my contacts with the Bureau have convinced me that the most extreme care is used to avoid placing the stamp of approval on any research results until it is certain that they are correct. The Bureau has a reputation for accuracy that must be always maintained, and it is meticulous in its care to do this. Likewise, it is a pleasure to be able to say that the results of the research in this field are open to every dentist and every manufacturer who cares to avail himself of them and use them in good faith. This is well known to be the status of all Bureau of Standards research results.

For efficiency in a wrought clasp, elasticity is an essential property of the material to be used. There are two forms of elasticity available for the use of the clasp technician, but only one of them has commonly been used by him in past decades. Both of these are governed by laws of physics which have been unknown to most dentists, and which consequently could not influence clasp practice. Comparatively recently it has been discovered, in the researches above referred to, that elasticity can be materially influenced by correct heat treatment—that gold alloys of certain formulae can be made to assume a maximum of elasticity by heat treatment—both processes being easy to apply in the dental laboratory. Therefore, we are justified in stating that alloys of definite and selected formulae, carefully manufactured, carefully manipulated by the technician at every stage of the work, and given adequate and carefully prescribed heat treatment, are just as important in the production of reliable and efficient clasps as are the same factors in the production of motor axles or engine shafts. There are other laws of physics that it is essential to know and to practice, if we are to avail ourselves of the highest efficiency obtainable in round-wire wrought clasps—service which shall obviate the need for more complex and more hazardous forms of retainers. These physical

laws relate to the comparative degrees of elasticity displayed by different lengths of wire of the same gauge and formula and different gauges of the same length. Lack of knowledge of these laws and their application is responsible for much of our inefficiency in the field we are now studying, and for many of our absurd experiments with other principles. If one quarter of the effort and expense attached to the invention and exploitation of devices which we ought not to use at all had been applied to research on the round-wire clasp, many of the former would never have seen the light, nor would they have been missed.

The two forms of elasticity are flexure elasticity, and rotational or torsional elasticity.[2] Encyclopedias use the term "perfect elasticity" by which they mean capacity to display elasticity within the limits of the factor of safety of a particular specimen of an elastic material, an innumerable number of times and still return exactly and completely to the original form. The typical example of perfect elasticity of flexure is the hair-spring of a watch, capable of expanding and contracting a certain distance millions of times, without taking on a new form, or set. We all realize, however, that if we expand the whole spring too far, or if we flex a short segment as far as the long one can be repeatedly flexed without deformation, it will set in another form and not return to the original. In other words, the longer the spring (clasp) the further it can be flexed without permanent deformation. The *important* thing in our study is not how *far* the longer spring can be flexed, but in the factor of safety resulting from that capacity. If a short clasp can be flexed one-thirty-second of an inch only before taking on permanent deformation, while a long one can be flexed three times as far without doing so, then it will be possible with the long one to duplicate the conditions of the watch spring and to bend it the required one-thirty-second of an inch a great number of times without damage. Translated into practice, this means, make your clasps as long as you can when ever you desire permanence of the elasticity factor.

The governing laws are: "*deflection varies as the third power of length;*" and again: "*deflection varies inversely as the fourth power of*

[2] These terms are used in the senses in which they are commonly employed in the science of mechanics.

diameter."[3] Translating this into practice, we find that the smaller the wire and the longer the clasp we can use for an individual case, the greater the deflection possible, and consequently the greater the factor of safety for a small deflection. This, in turn, calls for a wire of the highest possible elasticity and the greatest adaptability to heat treatment, because a small wire with these qualities will have the same retention value as the larger wire without them. And in addition, it can be depended upon to display the required amount of deflection to permit the clasp to pass over the contour of the tooth, and close up again to the desired smaller size, a great number of times without permanent deformation and consequent loss of retention value.

Torsional elasticity is in common use by orthodontists. An ordinary device in which it is displayed is the spring for closing a screen door, where a rod 2.5 ft. long is rigidly fixed to the door at its lower end, and to the casing at the other, in such a manner that opening the door produces torsion of the rod, and the elastic force so developed closes the door as soon as it is released. Here we have a factor varying inversely as the diameter, but also in direct proportion to the length. And this provides a further reason for demanding a wire capable of displaying the utmost resiliency, so that the small wire with the large factor of safety may have the requisite retentive capacity. Mr. R. L. Coleman, who reported the results of the research in this field by the Bureau of Standards and the Weinstein Research Laboratory in a paper published in the issue of the *Journal of the American Dental Association* for May, 1925 has calculated for me the comparative values of the two forms of elasticity, with very interesting results. I had been prepared to find that the net gain from the torsional elasticity factor was comparatively small in practice, but I was well convinced by clinical experience that it did exist, and that it added to the efficiency of clasps designed to permit its exhibition. The calculation was made on an assumption of equal length for two segments of a piece of wire so bent that the segments should stand at right angles to each other, one end being held rigidly while force was applied to the

[3] Deflection is properly but less commonly spelled "deflexion" (Latin, *deflexus*, pp. of *deflectere*, bend aside). It is employed in many senses. In the science of mechanics it is used to indicate the bending of material under a strain, as of a beam under the weight of a load.

other end, as in the case of a clasp going over the contour of a tooth. Under these conditions, torsional elasticity comes into action in one segment and flexure elasticity in both. The calculations indicate the value of the torsional elasticity of the one segment to be slightly greater than the flexure elasticity of both, but with a greater factor of safety for the torsional form.

Let us now consider the result of application of these laws and principles to round-wire clasp design and practice. The common practice has been to use a short clasp—often the shortest possible—and so to attach the clasp as to call into play only elasticity of flexure. Or if there was any departure from the shape of the clasp, or the position of its attachment from those features as they have obtained in flat-clasp practice, it was usually so slight that opportunity for display of torsional elasticity was practically non-existent.

Until very recently, adaptability of gold formulae to heat treatment has not been considered at all, and almost any spring wire was supposed to be satisfactory. Let us take, for example, a clasp attached to a saddle and intended to bear on the side of a bicuspid adjacent to its point of attachment. Let us assume that its resiliency is just short of that required to permit it to go to place without permanent deformation resulting, and see what will happen if we double or triple its length. This is not extreme because it is easy to provide for that much additional length; and, if it be required, elongation to four or five times the length of such a clasp is usually possible. If we double the length, but retain the same principle in form design, i.e., extend around the tooth in a single plane, the available flexure resiliency will compare to the third power of the length—it will be eight times as great, while it will be twenty-seven times as great in the clasp of triple length. This use of total clasp-length for our calculation applies only to the clasp that encircles the tooth in one plane, which is not usually desirable. When the design dictated by sound practice is adopted, with two or more segments standing at or approaching a right angle to each other, the total flexure-capacity is the sum of that exhibited by the segments individually. So in the clasp of double or triple length in segments each equal to that of the short clasp, the flexure factor will respectively double or triple. But if any one of those segments can be made longer, then its contribution will be as the third power of its length compared with that of the shorter segment.

When effort is made to design a longer clasp, the form that commonly emerges is one in which one or more segments stand at approximately a right angle to the terminal segment of the clasp. In practice, the force tending to expand the clasp is applied to the inner surface of this terminal segment, producing torsion of the segments that stand at any considerable angle to the terminal segment. This calls into service the torsional elasticity directly proportional to the length of the segment in which it is operative, but having in equal lengths of the same diameter of wire a value for the available torsional elasticity approximately twice that of the flexure factor and consequently providing a greater margin of safety. But this is not all we may do to increase our clasp efficiency. If we select a wire with a formula amenable to heat treatment, by which I mean one that becomes very soft when correctly annealed and very rigid and resilient when given correct heat treatment, we find we can reduce the gauge of wire required by two and frequently three sizes. Flexure capacity (equivalent for our purpose to elasticity) varies inversely as the fourth power of the diameter and when applied in practice to wire of B & S gauges, works out as follows: If, in place of 16 g. of a certain make of wire (a gauge which I have habitually used for many years for one type of clasp) there can be substituted 18 g. or even 19 g. of another make of wire (either of which gauges may be found desirable) then, 18 g. wire being used, the flexure capacity will have been more than doubled, as compared with the 16 g. size of the *same* wire. If 19 g. wire is used it will nearly be tripled. It is evident that we cannot state the gain in figures as compared with the 16 g. size of *another* wire, but we can test and have tested samples of two wires of the same gauge. The new wire was found to be more amenable to heat treatment and, when so treated, to be decidedly superior in capacity for repeated flexure without injury. So we can confidently assert that this ability to use a wire at least two gauges smaller is an important advance in clasp practice, because it enables us further to safeguard clasps against probable deformation, and so to increase the certainty of long and efficient service. The tests show the new wire to be capable of withstanding three times as many flexures as the older one before failing.

Let us revert to my previous reference to our failure to apply adequate analysis and ingenuity to the problem of eliminating the ob-

jections to, and improving the efficiency of, the round-wire clasp. Most of the factors I have so far mentioned were unknown to us until quite recently. It is probable that even ten years ago no metallurgist with the necessary grasp of dental technic would have been willing to make the requisite tests and experiments leading to the development of new formulae, involving the particular features of the problem to which I have so far referred, even if a manufacturer with the requisite foresight, equipment, and metallurgical skill could have been interested in their production. It also seems quite certain that as long as ten years ago, it would not have been feasible to enlist the aid of the Bureau of Standards, through whose coöperation there has been evolved the knowledge fundamental to and necessary for the progress in metallurgical practice and technic to which I have referred.

I cannot forbear giving expression here to my sense of appreciation of the work of the man who had the requisite foresight and initiative to conceive of this advance, and the willingness to make the investment required. You all recognize the fact that in the metallurgical data so far given you, I have depended upon the results of the Bureau of Standards-Weinstein Research Laboratory research, and that I am here referring to Dr. Weinstein.

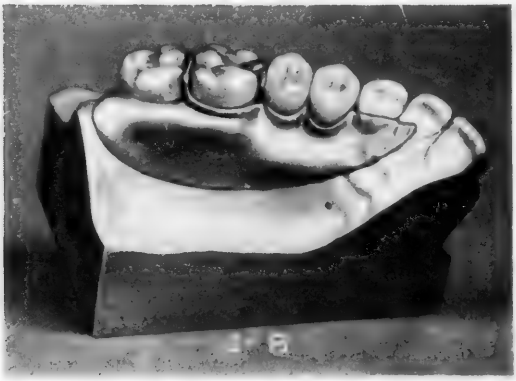
The facts above cited did not prevent the occasional dentist from making tests, by the time-worn trial and error system, of the possibility of obtaining better results with round-wire clasps than those which had characterized earlier efforts. And these men found that even with the better examples of wire available 25 or 30 years ago they could, by imitating and modifying the crib clasp of the Jackson orthodontia system, add materially to the value of the partial denture service of that day. In the period referred to, I was using such modified crib clasps as will be shown on the screen, and had occasion to be gratified by the superior service of the longer clasps. So I learned, by the somewhat painful process of trial and error, that within reasonable limits the longer the clasps, the greater the efficiency and reliability. The fundamental laws governing this fact were not clear until opportunity came to confer with the Bureau of Standard experts. But, fortunately, practical experience led me along the right road as regards clasp design, although the still better understanding of fundamental principles, which I now have, adds to the facility with which I can demonstrate the advantages to others.

I have already referred to the fact that commonly the round-wire clasp has been designed for the minimum feasible length. This continues to be true even in present day practice, partly because practitioners have failed to evaluate properly the *application* of a sound mechanical principle when urged upon them by technicians or by operators whose position seems to have been determined entirely by the mechanical aspect of the situation. These men seem to have little regard for the comfort of the patient, and no consciousness of the possible existence of other principles in clasp practice than those governing the selection of the point where the most efficient grip of clasps can be most easily demonstrated. And they apparently forget that the introduction of stabilizing lugs has reduced to a minimum the need for the heavy grip of clasps. Speaking solely from the viewpoint of the bench technician, there can be no question that the place to get readily an efficient grip on a tooth, with a clasp, is slightly rootward of the line of the highest contour of the involved tooth; and if a short clasp is to be used, this is the desirable place for it, because this location reduces the need for the display of any large degree of elasticity. The objections made by patients, when this location was selected for round-wire clasps in particular, very naturally and very properly caused practitioners to decide that clasps so located were unsatisfactory. Unfamiliarity with the laws of elasticity, which I have set before you, or in lieu of this, lack of initiative to search for and discover by practice the steps requisite for placing the bearing segment of the clasp at the neck of the tooth, where it will best serve the patient's comfort, resulted in discarding one of the best devices, if not the best, available to us both then and now, for the effective retention of partial dentures and bridges.

I desire to note here three exceptions to the dictum, stated above, that such a clasp should not be located just rootward of the line of highest contour. The *first* of these is the partial denture where the principle of stimulation of vital processes is to be utilized for health maintenance and for regeneration of underlying bony structure, which was so admirably demonstrated and explained to me first by Dr. George P. Phillips. It is my understanding that an essential feature of that system is absence of lugs or rests for thrust resistance, so that the full force of the bite thrust shall be sustained by the tissues under-

lying the saddle. Obviously, under this condition, the clasp must rest on the tooth well away from the gingival margin, and frequently high enough to approach the line of highest contour, in spite of the inconvenience it will cause the patient by its location at a point obtrusive to the tongue. The *second* exception is the leaning teeth where the utilization of all the advantages available to us through the application of the laws and principles of elasticity will not permit the clasp to be placed anywhere except as near the occlusal surface as is compatible with display of adequate retention. Here again the patient must submit to the inconvenience, if a clasp is the indicated device. Fortunately, most of the latter cases lie in the mandibular region; and the combined effect of their posterior location, and of the prominence of the linguo-occlusal surface of the tipped tooth, reduces the annoyance to a minimum. The *third* exception is the full crib-clasp of small-gauge wire, sometimes useful on bilateral pieces, in which it is usually requisite to locate the bearing segment of the clasp only slightly rootward of the line of highest contour. But it happens that the only cases in which this clasp would be used are those which bring the bearing segment of it on the buccal surface, and the small size of wire required in all these instances reduces the objection to nearly the vanishing point.

The question, whether the location of the bearing segment of such a clasp just rootward of the line of highest contour is the one for demonstrating its greatest efficiency, is ordinarily strictly academic. Utilization of the principles I have called to your attention so increases the efficiency of the long, round-wire clasp that in every way it is superior to the short clasp that is commonly advocated by those who would insist upon the higher location as the correct one. The correct location for the horizontal segments of round-wire clasps, on teeth having normal gingival tissues, is in the angle formed by the junction of the tooth surface and the gingival margin as close to that margin as is compatible with assurance of freedom from impingement upon it. At that point, it can always be made so unobtrusive to the patient as to be readily accepted. When I make this statement, the question is always asked: "What about clasp relations to incipient decay or erosion in those locations?" The answer is that if neither of them has already begun, and if your piece is properly stabilized, you need



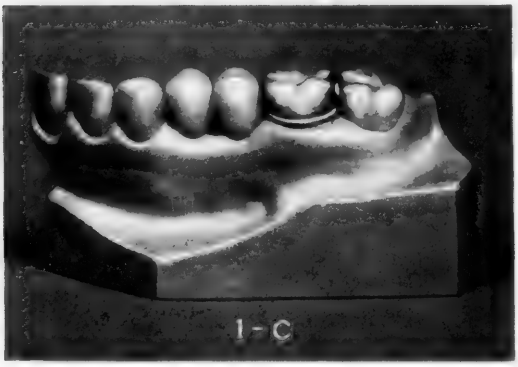


Fig. 1-A. Cantilever saddle with modified crib-clasp attached nearly in the middle antero-posteriorly, stabilizing lug in molar, and saddle resting against cuspid. Note that pressure buccally, such as occurs when clasp is going to place, will induce torsion in the two perpendicular segments and flexure in all its segments. In an unclean mouth, the rest against cuspid and lateral should be by stiff clasp-metal fingers.

Fig. 1-B. Palatal aspect of bridge illustrated in *fig.* 1-A, in place on model, showing point of attachment to saddle, and relations to palatal embrasure and to groove cut in the region of occlusal embrasure between molar teeth.

Fig. 1-C. Buccal aspect of bridge shown in *figs.* 1-A and 1-B.

Fig. 2. Full crib-clasp, soldered to saddle at each end. It is *not* attached to the lug, but lies free in a groove in its occlusal aspect. This clasp does not utilize torisonal elasticity. It is of value *only* on bilateral dentures and bridges, and its illustration here, for convenience on a unilateral bridge, must not be intepreted as endorsing such usage in practice. Gauge 20 or even 21 will often be found large enough for this clasp, facilitating its use in close bites.

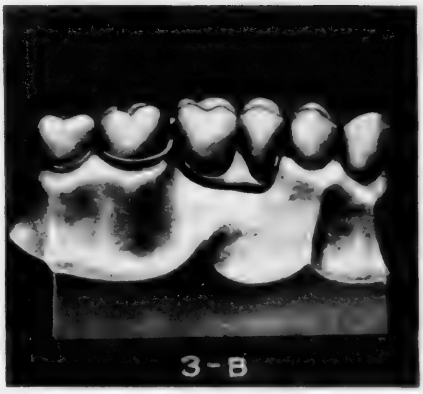


Fig. 3-A. Palatal view of bridge with two lugs, molar clasp with two arms of two segments each soldered to molar lug and bicuspid clasp with one arm of two segments soldered to bicuspid lug, the latter clasp operative on palatal side of tooth and opposed by rectangular stabilizing lug, which makes effective the clasp grip; and, by reason of the relation of its flat sides and seat, resists tendency of light clasp-grip to shift position of tooth. If, because of a much contoured tooth, or for any other reason, it were desired to use on such a bridge the modified crib (Gillett) clasp, it might easily be done by extending saddle alongside of molar to provide for the required attachment at its disto-palato-approximal angle, permitting the occlusal segment to lie free in the groove cut in lug. A second variation would be to solder the clasp at its mesio-palato-approximal angle, permitting the edge of saddle to make the necessary tooth contact to oppose clasp. Both of these plans serve to lengthen the clasp, and consequently increase its factor of safety as related to possible deformation, breakage, and durability.

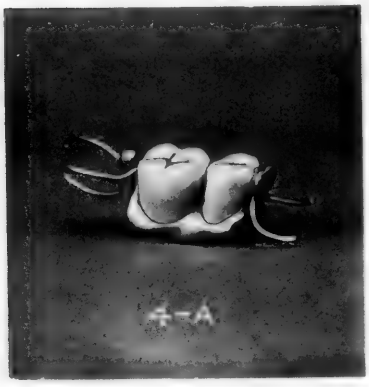
Fig. 3-B. Buccal view of bridge shown in *fig.* 3-A. Note absence of buccal arm of bicuspid clasp.

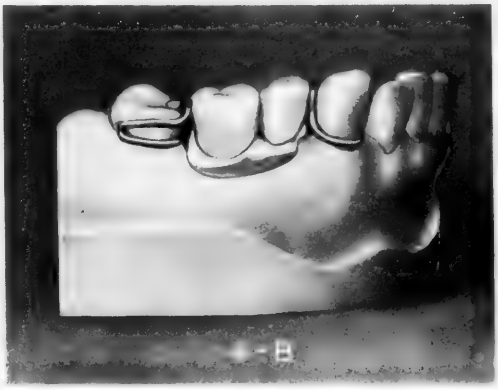
Fig. 3-C. Distal end of bridge shown in *fig.* 3-A, showing molar clasp and lug.

Fig. 3-D. Anterior end of same bridge (3-A), showing single clasp-arm and nearly rectangular form of stabilizing lug.

have no hesitation on that score in so locating your clasp. And if either of these processes has already begun, then restore the normal shape of the tooth with a shallow gold inlay before you take the impression for the model on which the clasp will be formed.

On this occasion we cannot properly discuss the wires of different manufacturers by name. Until we arrive at a stage of development where we are equipped to specify formulae and, still more important, the required properties, and understand the comparative values of the properties and formulae and their interrelations, we shall be handicapped in the most efficient utilization of metallurgical knowledge.





Figs. 4-A and 4-B. Illustrate one way of gaining length of clasp.

The study by the Bureau of Standards and the Weinstein Research Laboratory has resulted in the development of apparatus with which reliable tests of different formulae of elastic wires can be made. When the best formulae for any given purpose have been selected, we must then depend upon the good faith of the manufacturer in supplying the exact product specified, which is of course, the only sane policy for the reliable manufacturer. And quite as important, we need to be assured that the technical steps in his compounding of the elements of the alloy are correctly carried out and consistently duplicated with each batch; also that the mechanical steps of drawing the wire to size are accurately and consistently performed. A good formula is value-

less if the alloying is improperly done. The result with different lots from the same formula will vary if the sequence of steps is varied, or if meticulous care to exclude accidental impurities and dirt is not observed. The properly alloyed and carefully protected product will be ruined for clasp work, if there is any failure strictly to observe correct principles of shop practice in annealing and drawing the wire. I am told that a workman can deliver a perfectly good-looking but valueless product by so simple a variation as the skipping of some of the holes in the drawplate in reducing the size of the wire.

Since the highest grade of material for such clasps as I have described will seldom cost as much as 50 cents each for the largest, there would seem to be little need for other grades in clasp practice, for confusion would probably result if other grades are provided. However that may be, it is desirable to say emphatically that, when small-gauge wire is to be soldered, it should be a wire with a high melting-range, for two interrelated reasons. The higher the melting range, the greater the margin of safety between the fusing point of the solder and that of the wire; and, since a small wire very quickly takes on the maximum temperature of the blowpipe flame, it is easy to damage it inadvertently. More important than this, however, is the recently discovered and as yet incompletely investigated fact that such a wire may be badly damaged, and rendered incapable of displaying its best qualities, at a temperature so far below that of its complete fusion that no evident outward change will have been produced. I pretend to no knowledge in this field, but the effect described to me would be as I expect, if it were possible to show that the metal (or metals) with the lower fusing points in an alloy begin to melt first, and so change its character to the detriment of some of its properties, before the higher fusing metals have been sufficiently affected to permit the wire to change form. This is suggested with no claim that it is the full explanation, but purely as a hypothesis in an effort to facilitate understanding. Larger wires, with a smaller margin of difference between their fusing points and those of the solder, may be used with less risk than is the case in the use of small wires, but I can see little inducement to use them unless there is some other reason than that of economy, because the saving of six to possibly ten cents does not warrant acceptance of the hazard it entails.

Before beginning the shaping of the clasp, have at hand numerous forms of smooth-beaked pliers of assorted sizes and shapes, and see to it that any pliers with angles on the beaks are placed out of reach, because the wire for this use must never be scratched, nicked, or deformed in its cross-section, and handling it with pliers with sharp corners always ruins it. Wire so damaged must be discarded at once.

Now, a few words about heat treatment. What I have to say about this feature has been taken from the paper by Mr. R. L. Coleman, printed in the *Journal of the American Dental Association* for May, 1925.

For elastic wire of formulae suited to clasp practice, i.e., displaying a high degree of elasticity, and yet capable of extreme softening under proper annealing, the correct procedure is as follows: Provide yourself with an electric oven capable of developing and maintaining temperatures up to 1000°F., with a reliable temperature indicator and a rheostat control effective for any temperature below that point and down to 400°F. Some of the desired results can be made available by the use of the blowpipe and home-devised apparatus, but with such procedures the apparently essential feature of *uniformly graduated* and time controlled cooling is not feasible, so it seems undesirable to attempt their description since a suitable oven will soon be available. The annealing may be done by heating the wire to a cherry red in the Bunson flame, and quenching it instantly in water or acid, which will develop its softest condition. Care should be taken not to heat above a cherry red as this may ruin the wire, and in soldering wire of this type, care should be taken to use as low a heat as possible. The best grade of such wire can be soldered with 22 K. solder without damage, if the heat be kept as low as will serve to fuse the solder adequately. The shaping having been finished, all soldering completed, and relation to cast verified and corrected if necessary, the piece should be boiled in 30 per cent nitric acid, then heated to 900°F. in the oven, and held at that temperature for ten minutes. The heat is then cut off, and the piece allowed to cool gradually in the oven, which is kept closed down to 400°F. This should take at least fifteen minutes. With some formulae as much as thirty minutes is permissible. However some formulae on the market are ruined by the longer period of cooling, for it causes them to become very brittle. The minimum of

fifteen minutes for *uniformly graduated* cooling is imperative so far as present research has determined, but variations of as much as 100° in the temperature stated are less important. Below 400°F. temperature changes do not in any way modify the physical properties.

In closing, I want to say, in all earnestness and good faith, that if you will master the principles and technic of the use of elastic round-wire for the retention of partial prosthetic restorations of all classes, and if you will train your technicians in its mastery, you will get increased satisfaction out of the progressively more valuable health service you will be able to render your patients.

140 West 57th Street,
New York City

THE RELATION OF THE DENTAL PROFESSION TO THE PUBLIC HEALTH[1]

LOUIS I. HARRIS, M.D.

Commissioner of Health of New York City

It is a privilege to have the opportunity of addressing you on "the relation of the dental profession to the public health." There is no contribution that I can make that is signally valuable, or that will have any element of surprise or novelty. I am really to speak on a topic that is self-evident; it needs no elaborate argument. It needs no long presentation of facts and reasons to establish the validity of the theme that has been given me as the title of my talk tonight.

The President, in his introduction, alluded to a dental viewpoint that I have. If I may allow myself rather a labored attempt at facetiousness, I should say that my dental viewpoint, thanks to the exploitation of dentists who were not dentists, is not one that would regale you. If I were to permit you to see what a victim of dentistry I have been, you would realize that my dental viewpoint is inspired by rather shabby dentistry and that it is a pleasure to be present at a place which is dedicated to idealism in professional work. You, like the New York Academy of Medicine, have apparently set for yourself a level of achievement, a standard of conduct, a viewpoint with respect to your professional obligations. This makes it particularly important and particularly delightful to have an opportunity to speak to you on the next steps in our realization of the ideals that we have in common, for dentistry and medicine are closely interwoven, closely interlocked; they are integral parts of the healing art. If you would, you could not separate them. That this viewpoint has not gained common acceptance, or has thus far received only lip tribute is very much to be regretted. But, by the formation of an Academy, small in numbers as yet—larger in numbers, may I express the hope, when

[1] Address delivered at a meeting of the New York Academy of Dentistry, Hotel Commodore, New York City, November 18, 1926.

those who are your fellows in the art and science of dentistry have raised themselves to a higher level—you have demonstrated that there is a sense of obligation and responsibility, and a certain ethical obligation that will not allow you to rest content with your individual achievements, your individual contributions to the healing art. We, in the medical profession, owe it to you to ally ourselves in a way that will leave no doubt in your mind that the best element in the dental profession and the best element in the medical profession see eye to eye. The professions are merely different divisions of that great alliance, that offensive and defensive alliance against disease, which ought to be created and built up to as high a level as possible.

The extent of mouth disease in New York City is of course not to be stated in precise figures, but I make bold to say that the examination of school children, the examinations by the military surgeons, and by those who are actively engaged in the recruiting of our military forces during the recent war, indicate quite clearly that we can not overstate the magnitude of the problem that presents itself. A variety of pathological conditions of the mouth are recognized (and I shall not offend your intelligence by telling you facts that you know so much better than I, so much more intimately), and it needs no argument to make good the contention that disease conditions in the mouth are a very potent factor in creating serious constitutional disturbances. The rising tide of heart disease, so frequently referred to in the current dramatic language of the statistician, is a thing that is not remote from pathological mouth conditions.

The number of signs that blaze here and there (I mean blaze literally) throughout various parts of this city, this the greatest, the biggest city at least in the United States—advertising painless dentistry; advertising the abominations and the atrocities that pass muster as dentistry; the abominations that conceal putrid, festering, putrescent conditions—constitute a challenge to the best men among you. When I say among you, I do not mean you of the Academy; I mean dentistry at large, for you are only blazing the way, you are establishing a standard by your Academy. I make bold to say that until the medical profession, and the dental profession, the County Medical Societies as spokesmen for the medical profession, the Health Department as spokesmen for the community as a whole and the

professional elements in it as well, and the newspapers, all unite to educate the public, and to make them aware of the dangers that lurk in these "parlors" that still abound, we shall have a continuance of conditions that threaten the welfare of multitudes. These conditions cannot help but cause grief to those of us who know the consequences of dentistry that is not dentistry, but for which we lack a name that is sufficiently distinctive and that will sufficiently condemn the practice.

We must recognize that the public have a state of mind that is exceedingly receptive to education at this juncture. My leisure since January 1 has been notably conspicuous by its absence, but in one of those moments when I hurried to a barber, and allowed him to minister to me, I had an experience that impressed itself upon my memory which was rather significant and amusing. In one of the places where the promise is supposed to be kept, where it is kept more or less, the barber began his ministrations upon me, and I submitted to them in silence. What else is one to do if one is tired, and if one wishes to defend one's self against endless loquacity? I found, however, that I could not, by my silence, quiet this gentleman's eloquence, and he insisted upon telling me a number of things that were good for my hair and my scalp. I had my set views, but he gave me no opportunity, nor had I any desire, to enlighten him and express them. He continued to regale me with his knowledge of the needs of the physiology of the scalp and the hair, and finally he began to talk of dentistry. Why, I don't know. I gave him no view of my mouth. He felt that that was a relevant subject. He wound in up a peroration that was rather unusual. I don't know whether you have heard it; to me it was novel. He said, "That is why I say to my friends, be true to your teeth or they will be false." That was rather a significant statement. That man was a health educator. He had caught a rather scintillating, excellent, dramatic phrase. He had expressed, in a rather facetious and no very scientific way, the problem that exists for us and showed that the layman is alert and alive. There was more than merely a happy phrasing in that statement of his, and I have had many manifestations of a public alertness and awareness of the need of proper care of the mouth, oral hygiene, if that name be all inclusive enough. We ought to capitalize that, and we must capitalize it in ways that are aggressive and yet dignified.

Now, I may, as your spokesman, throw a certain measure of dignity to the winds, for I am primarily, as I conceive my function while I survive in office, spokesman for the medical and dental professions and for all those who are at all allied to the healing art, and I am also spokesman for the community. If I am performing my duty, if I am fulfilling my moral obligations aright, it is incumbent upon me, even though I might possibly shrink from publicity, to speak, and to speak aggressively, with respect to the place that dental hygiene has in the scheme of public health. Dental hygiene has only begun to make its contribution. I am rather ashamed to take stock of our slender resources for protecting the public health. When I consider how few are the clinics that the Health Department operates, and when I consider how many are the numbers who cannot afford the oral hygienic care—when I consider the poverty of resources of those who are denied dental care—I cannot help but feel that the municipality owes it to these large numbers who cannot afford it. The municipality should give them proper ministrations, in well equipped, well organized, well conducted, scientifically directed dental clinics, employing the best and most competent dentists, to do whatever branches of the work may be counted upon as fundamental—not the frills, not the fads, but fundamental treatment. It is my hope that what we are doing today will be a demonstration of how to meet a need that is real, a need that is substantial. It is my hope that the Dental Advisory Board, which has come to join me and make an effort to collaborate with the Department of Health, and which numbers some of the very best men in your profession, will help me evaluate the work now done by the dental clinics which have been thus far organized. Whether under private auspices, or under public auspices, I hope that the result will be some unifying standards, out of which will develop some well directed and well organized scheme that will be beneficial to the public health. I am exceedingly anxious for it, and I may summon the Dental Advisory Board very shortly and place my problem before them and ask them to give me a professional appraisal of what all the dental clinics are accomplishing, to cite their merits, and also to stress their defects, to the end that we may go forth constructively. This is the big thing that we need. Let us not forget that the dental clinics, whether they reach only the poor, or those

in moderate circumstances as well, can be utilized as educational centers, where children of plastic mind, children who are ready to receive any suggestion, good or bad, may be given the desirable suggestion of oral hygiene. Periodic health examination of the mouth is a part of the periodic health examinations that medical men have been battling for, and which are slowly coming to be recognized as essential parts of our preventive public health program.

I cannot overemphasize, though I will not dwell at length upon, the educational value of the dental clinic. I do not know anything that we do that is so vital, so important, as inculcating a proper attitude toward medicine. And now for the moment I shall not talk of the dental profession as separate and apart from medicine but all of medicine. We must stress, we must bring home to the children, a realization of the rôle that medicine has to play in safe-guarding against disease, or in dealing therapeutically in a decent and sane way with the conditions that are confronted in the schools. The preschool age group has been a much neglected group. Our principal emphasis thus far in the public schools has been with that group of children who are well organized, who are marshalled and corralled in the public schools. There we find them foregathered. There we have the means of dealing with them collectively. What a pity that there is not some form of organization that will in like fashion, marshal the host of children of preschool age? Seventy-six per cent, if my memory serves me right, of all defects found in public school children, without regard to their age, are found at the time of their entrance to school. I need not here dwell upon the significant rôle that dental defects and mouth pathology play in this array. Of course, our examinations in the public schools do not pretend to thoroughness. The medical inspector who takes the spatula or the tongue depressor and lifts away the buccal tissues and gets a view, more or less thorough, of the teeth and presumes to pass judgment upon their state of health, is perhaps not the person who is most competent to do that work. The time is not far distant when, adopting the scheme that has been used in certain cities, we shall organize small squads of specialists among whom shall be numbered the dental specialist, who shall give an appraisal of the condition of the mouth that would be proof against any criticism. Then indeed I think we shall discover many more defects than

are discovered today. We shall see defects in their incipiency, which now are not recognized by the man who has a general medical training and who, perforce, cannot be acquainted with all the intimate details of dental anatomy and pathological physiology. These are things that need stressing.

There is a new branch of dental science, a new specialty in dentistry, to which I wish to allude—orthodontia. I understand there are five orthodontists present in this group. I have made a rough classification of your age distribution and of your specialties. I have been busy inquiring. To those five, and to all dentists, all fellows of the Academy, I would say that if the work of the orthodontist is validated, if it stands on a sound basis, if it has a contribution to make that is vital, important, and necessary (and I believe it has a contribution to make, without knowing the intricacies or the details of the orthodontist's specialty), then it is greatly to be regretted that the benefits of that work are enjoyed at the present time exclusively by the rich and the well-to-do. Some way must be found to make the orthodontist's work a thing that is a definite contribution to the well being of those who are not so well circumstanced materially that they can avail themselves of this valuable service. I do not yield to anyone in my general understanding and appreciation of what that service has to accomplish, but on this occasion I cannot help stressing the real need of making it more generally available. How, is the great question. I realize the labor involved. I do not minimize the expense—the energy required. But if it is good, and I believe it is intensely good, then let us take thought as to how to make its benefits enjoyed more widely, a thought that you may grapple with, and which I will be delighted to help you grapple with, if I may be admitted to your councils. I am not at all ashamed to confess that I am not overburdened with this world's goods. I have the problem in my home, and I am rather "stumped" by it (if in the confines of the academic walls I may use vernacular that is inelegant). It is the financial obligation, that is the problem involved in having my children's dentures corrected and put into proper alignment, and to have certain tendencies toward abnormal growth and development corrected by the art of the orthodontist. I am neither poverty-stricken, nor can I plead that I am a proper recipient of charity, but I do find

it a very serious problem. You must help me solve it, as I voice it for the multitudes who need it, and there is a tremendous field there. Whether you will organize groups of orthodontists, and do collectively the work that it is impossible to do individually without tremendous cost, is a suggestion that needs consideration and far more deliberate debating than we can give it, or than I can give it here, but I throw it out for what it is worth.

I am exceedingly anxious to make it known that, while in this year's budget the Department of Health did not fare as well as I hoped it would (it did not fare well at all with respect to dental work, as dentistry got practically no recognition this year), I have not paid mere lip tribute to the need of dentistry in the public health program, as I hope to evolve it. May I take you into my confidence? We are just now in the throes of reorganization of the Department of Health. We have needed it badly. We have passed through some lean years. I shall not say whether they were seven or less, but we have gone through some lean years from the public health and scientific standpoints. I say that without lack of generosity to my predecessors. I say that because facts need to be stated bluntly and honestly. Upon the honest statement of fact is predicated constructive work, advancement, and progress. It is not to be denied that the Health Department, which once held a very proud estate, suffered severe blows, suffered from disintegrating forces, and demoralizing tendencies. I think we are on the way to correct them. Forty-five men have walked the plank for conduct that was subversive not merely of good discipline, but also of the basic principles of decency and humanity. They were men, and a few women too, who compromised with their conscience. They were persons who, charged with high obligations, entrusted with duties that were solemn and important, were willing to barter away the public health for a few dollars, in some instances for very significant and enormous sums. The amount of money that passed hands varied very much with the art and the knowledge and the skill and the finesse of the individual. We have gotten rid of those. It has been a nauseating, an unpleasant chapter in the history of our public health work. It had to be done. We are now on the threshold of reorganization. There sits at this table at least one who shared in the preliminary conferences of reorganization of the Depart-

ment of Health. I refer to Dr. Healy, President of the New York County Medical Society. I think it is necessary that in any such conference we have adequate representation of the medical profession.

I come to you tonight and say that in this process of reorganization, dental work will undoubtedly come into its own, if there be adequate study of our needs, a scientific presentation of the needs that have not been adequately met and of the volume of work that still remains to be done. You can help me, as no other professional group can. You are banded together for ideals, for the development of a standard of ethical conduct, as well as for the encouragement of research, and nowhere could I more properly ask for the collaboration and the assistance, which it is your privilege and your obligation to tender, not to me but to the community. I say advisedly, that in the course of this year the Dental Advisory Board, representing the dental profession, should make a careful study of the needs of the situation, and should come forward with suggestions that are concrete, and well thought out. Then, by your alliance with the newspapers (the fourth estate, which is very important)—by your alliance with those who will intelligently and aggressively say the things which you professionally cannot say too aggressively, too belligerently—you can be of such influence that, when we come to ask for our next budget, there will be a public sentiment behind it to make it as impossible for the administration to overlook the needs of this departmental service for the benefit of the great masses who need it in the city, as it was for them to overlook the imperative and the insistent demand of those who asked for the $400,000 additional appropriation which we recently secured. That marked a red letter day in the history of public health in this city. I tried to carry dental hygiene along. I did not because early in our work we were halted. There was an unfortunate lack of proper organization and proper development. The foundation had not been laid securely, and we could not come with good grace and ask for a budget appropriation when we had not the defense that we sought, when we had not validated our claim to a larger budget. Do I believe that more money is needed for dental work? I believe it with all my heart and as intensely as a person can. It allows of no argument, but what you and I know individually, or feel collectively,

must be presented in a way that will brook no contradiction on the part of the man in the street, the tax-payer, the critic and the real estate man, who is the perennial critic of every group that asks for an increased budget. We must be so armed, so fortified, not only with the facts that show the need of the situation, but with the ability to show that what we have done thus far is excellently done. I feel a very strong dependence upon the Dental Advisory Board of the Department of Health, and I look to them frankly, relentlessly, fearlessly, to state the defects in our present method of organization, if defects there be in it, and I suspect there are—to say so without fear of giving offense, and to quickly remedy those defects, to the end that we may march before the Board of Estimate, figuratively speaking, next year, armed with a consciousness that what we are asking for is an extension of work so well organized, so well performed, that its benefits, its contribution to public welfare are indisputable. There is much, therefore, for us to do collectively.

The seeds we plant among the school children, among the children of pre-school age in particular, are important, and I should say that it would be to your interest and to the interest of the Dental Advisory Board, which represents you, to inquire as to the organizations that deal with children of pre-school age. I am most concerned with the pre-school age. If you could have seen the response that was made by the Association of Day Nurseries, which met yesterday in convention at the Hotel McAlpin, when I approached them on the subject of dental work as a part of the program of protection of the health of pre-school-age children, you would have recognized at once that the 2500 children that are gathered under the roofs of the respective nurseries in the city constitute one nucleus. And if nothing more than for purposes of demonstration, it is your business and mine to show what can be done with that group, because so few of the pre-school-age children are so organized.

It is my hope and aspiration that dental clinics will be established in greater number in the schools where there has been construction to warrant the placing of dental fixtures and dental appurtenances and equipment, and that in those schools we will not only cater to the children of school age, but that we will invite parents to bring in, for

preventive medical examination (a well-rounded medical examination, including the dental aspects), all the children who cannot afford to go to the private offices of physicians and dentists.

Nothing that I say should be construed by anyone as indicating a desire to pauperize, a desire to supplant private practice with public practice. I do believe, for example, that in our public practice we are doing too many school examinations and health examinations. If parents who are well-to-do realized the importance of health examinations, their children would not wait for those three casual examinations which a child receives in the course of its school life, but they would be so persuaded of the value of periodic health examinations that right from the beginning, from infancy through life, they would establish the habit of periodic appraisal of health assets and health liabilities, and by that means secure the well being of their precious charges. Nothing that I say is to be construed as meaning that we are going to supplant or in any way invade the field of private practice, but private practice and public work are inextricably bound up. They are part and parcel of a uniform program, and I say to you advisedly that we have much in common.

I pay no lip tribute to dental hygiene. I say at this time, as I said to you on another occasion, shortly after my induction into office, when it was my opportunity to address the members of the dental profession,[2] there are many things in the program of public health that clamor for attention. I cannot promise that every day and all the time I shall be shouting with enthusiasm, and working with a single eye to the achievement of a better dental program. Mental hygiene clamors for attention. A real program of school medical inspection, that is worth while, clamors for attention. Then, there is a revision of our venereal disease work. Oh! there are such a host of things that I dare not begin to enumerate lest I take up more time—they all clamor for attention in the scheme of reorganization. I hope the foundation will be laid, at least, for a proper proportion of the amount of attention and work that is to be given to each of these.

I have talked far longer than I expected. I hope that I have been successful in carrying the conviction that I do look forward with

[2] Harris: *Journal of Dental Research*, 1927, vii, p. 109.

anxiety, with solicitude, with interest, to the developments of the next few months. I say at once that we got nothing in our budget for oral hygiene. But let that not discourage you. Let that not be interpreted as indifference on our part or for a lack of appreciation of the significance of the dental program. And may I ask you, through your Dental Advisory Board or through any other instrumentalities of the profession, to put dental prophylactic work, which your profession has to offer, on the map so securely that when we come to ask for next year's budget, we shall find civic forces, the newspapers, and not least the medical profession as a whole, through organized medicine, proclaiming the need of oral hygiene and demanding attention for it in proportion to its needs.

DISCUSSION

Michael M. Davis, Jr., Ph.D. (New York City): Since I am probably the only person here who is not a member of the medical or the dental profession, though I have had intimate contact, I am happy to say, with both professions in New York and elsewhere, I can speak from the point of view of an outsider looking in. My attempt to discuss Dr. Harris's paper reminds me of a story I heard the other day of the man who met two of his old friends as he was coming out of St. Patrick's Cathedral. They hailed him with, "Where have you been John?" To which he replied, "Inside confessing all my sins." "Oh!" said one of them, "how unnecessary!" "Oh!" said the other, "what an excellent memory you must have!" Comment on, or criticism of, Dr. Harris's address seems unnecessary on the one hand, while on the other hand one would need a better memory than mine to remember all the points with which he has illuminated us. However, from the standpoint of an outsider looking in, I believe no one in such a position can be otherwise than greatly impressed by the way in which the public point of view toward dentistry has changed, and is continuing to change, in the direction of a higher appreciation of the significance of the dental profession and of its contribution to public welfare. One doesn't have to look back far to reach the time when dentistry was only a resource in time of pain and distress, and when an address by a public official on the relation between dentistry and public health would have been unthinkable. Nobody would have dreamed of suggesting such a subject for such a speaker as we have had tonight.

The need that Dr. Harris has pointed out exists, but its very recognition

is new even among medical or the best informed lay circles. The creation of that recognition, or of its beginning is, of course, largely due to the activities of health organizations, municipal and state health departments, and the voluntary health organizations who have done so much to educate the public in all directions concerning health. Some phases, with which we are all familiar, have been due to the activities of commercial organizations. There is no doubt that the prevalence of the tooth brush and the tooth paste is due in part to the commercial advertiser. A friend of mine who happens to look very much like one of those four persons for whom it was too late, and whose face is widely displayed in the advertisements, is strongly convinced that either they should not advertise so much, or he should receive a financial return for having his face unwittingly displayed, though they have indeed partly disguised him by covering up the mouth. This publicity has not been entirely advantageous; there have been dangers as well. The New York public has not been sufficiently awake to its dental needs to demand, even without a Commissioner's request, that the public health budget contain the steadily increasing appropriation for dental service in the schools, which is so necessary. The public is, however, slowly beginning to realize the situation and will undoubtedly be further awakened.

There are certain factors which need to be kept much in mind, particularly in this City, for the size of the problem in New York is stupendous. We are familiar with the much more extended dental services for children in Boston. But Boston is a city with less people in its whole population than the school population of New York. Likewise, Rochester, with its even more extended dental services for children, has a population of only about 300,000. In Rochester it is probably true that every child of school age, and quite a proportion of those just under school age, can and do receive needed prophylactic dental attention, and a good deal of the curative work which they may require. A program of that kind in New York City would mean provision for over 1,000,000 children, not counting those under school age, since we have some 700 public schools, some 250 or more parochial schools, and an unknown number of private schools, a total of perhaps 1000 schools in the city. Were we to consider expending, as some other cities are doing, an average of between $2 and $4 per year per child for prophylactic work, the total sum in New York, while perhaps not large in proportion to what is already being spent for education, nor large in proportion to the wealth of the city, would be in itself so enormous as to cause a seriously increased mortality among the already shell-shocked members of

the New York Real Estate Board and would be entirely beyond what we can expect to achieve for many years to come.

The discouraging part of it is the magnitude of the problem. Any attempt to handle it as a whole, any attempt to put through a complete dental program, as would be theoretically desirable according to our present knowledge, would be to my mind—for I can speak frankly before an audience of this kind—practically unthinkable. It carries this lesson which I think has an important bearing on the program that Dr. Harris suggests, namely, that since we cannot get enough dollars to go the whole way, we must be particularly careful that we spend in the very best way the few dollars we can get. How to spend those dollars best isn't a question of detailed administration. It is a question of the policy under which they are spent. That is a much more fundamental matter than the particular technique of the clinics or the other services which are set up. The policy under which a program should be worked out, when the money is so limited in proportion to the total work that should be done, must be one in which careful selection is made along at least two lines: first, as to the kinds of dental work that it is most important to do, and second, as to the groups, by age particularly, whom it is most important to reach.

Is it true that, in order to reach the younger children and for the sake of the best results ultimately, it is best to let the older children go untreated? Is it the best plan to concentrate on oral prophylaxis, and neglect the filling and reparative work among the little children? What supplements or additional services beyond simple oral prophylaxis should be carried on? It is important to define, as carefully as possible, the exact activities that will make the most of the expenditure of a certain number of thousands or tens of thousands of dollars—at which rate, rather than in millions at a single jump, budgets for dental work are likely to grow most fruitfully. That is a matter which the scientific group in the dental profession, such as this body represents, combined with the related scientific groups in the medical profession and in the field of public health administration, must consider jointly with the utmost care to see what will make the limited dollars go farthest.

From the standpoint of the general public, no one I think can lay too much stress on the factor of cost to which Dr. Harris adverted. After all, the cost of dental service is the greatest obstacle in the way of meeting public needs fully. Whatever may be felt about the relative significance of dental services, compared with other forms of health services in medicine, there is no question that the incomes of the general population are not

sufficient, at the present time, to pay for the all desirable dental service. When we consider that the best available statistics indicate that, for the family in New York City with an income of between $2000 and $2500, a year (which represents the great bulk of the self-supporting population) the average expenditure for all forms of health service—medicine, nursing, dentistry, hospital care, etc.—runs in the neighborhood of $60, and then compare this sum with the cost at minimum private rates of even the limited amount of dental service desirable as a routine for everybody—say the minimum amount of dental prophylactic service for a family of five—we realize that a family of this income level cannot possibly pay for even the minimum program of preventive and curative dental service at present costs. Private practice as well as public practice in dentistry must face this situation. It is not possible to expect anything like complete, one-hundred-per-cent attention, to the mouths of the living population. It simply can't be paid for and it won't be done. Even if there were enough dentists to do it all, a matter which it is difficult to judge, the cost would be prohibitive. The total amount of dental service that ought to be developed for the mass of the self-supporting, but not well-to-do population, is undoubtedly far beyond what can be developed. Here again selection must be made as to the most important kind of service, that most needs development.

No one, I suppose, can do more in a few minutes' talk than make one or two slight suggestions in the direction along which, from the lay standpoint, one may hope that attention will be especially turned. How can the cost of dental service to the public be reduced? In saying reduction of cost of dental service, I am not thinking of a reduction in cost at the expense of lowering of quality, or lowering of professional standards. That is the last thing that would be desirable from the public standpoint, as well as from the standpoint of the dental profession. What I mean, is the reduction of the cost of dental service to such an extent that the public will be able to pay for the service it needs, on a basis consistent with adequate service and reasonable professional remuneration.

In the first place it is probably true that some reduction of cost can be brought about by further study of the organization of dental service. We have the best example of that in dealing with the problem of the child, because it has been fully recognized, by the leaders of the dental profession, that prophylactic and some curative dental service to the children in the population as a whole cannot at the present time be provided by individual private practice. It must be largely done, the prophylactic work at least, through organized practice in some form, supported by private or

public funds or by insurance or industry. At any rate, it must be done largely in an organized way. Organized dental service in certain specialties is particularly needed. Orthodontia is perhaps the best example, because of its high cost at the present time. How far can this cost be reduced by the development of organized services, on a basis consistent with the self-respect of the population, and on the other hand with adequate standards on the part of the dental profession—standards, which of course, will continually rise?

In the second place, the advance of preventive dentistry probably offers the greatest hope that costs may be reduced. As a result of more complete development of preventive dentistry, the need for the various expensive forms of curative dentistry will, it may be hoped, diminish in the future. The relatively few laymen who are keenly interested in this subject are apt to overook this, thinking as they constantly are of the question of cost, the over shadowing problem from their standpoint. From their point of view, this problem can probably be dealt with most effectively by the extension of preventive service in dentistry, which by dealing with evils at their source, will reduce the future cost of service to the population to a point at which it may be met. That will be very beautiful from the standpoint of a long range prophetic view. But the layman is much puzzled when he turns to the members of the medical and dental professions, by whose advice he would be guided, and asks them just what the best and coming forms of preventive dentistry are, for there isn't entire agreement as to what that best is.

Thus, I am puzzled when those interested from one point of view cry out for nothing but oral prophylaxis of young children; when others, equally enthusiastic, urge that certain forms of curative or other types of work, beside prophylaxis, be also done for those children as preventive measures; while still others lay great stress upon the nutrition of the child and the expectant mother as a vital preventive measure. They almost make one think, as one leaves their sanctums, that, if enough good nutrition work were done, the need of doing anything in the mouth would vanish in another generation. To tell the truth one comes away from a series of interviews with different specialists in an uncertain frame of mind. To me that means that research, funds for research, men for research, and material facilities for research, are perhaps the most vital needs in the whole situation. Part of that research is a laboratory job and part a field job. Here I come back in the cycle of my remarks to Dr. Harris's talk, because it is the field job that is going to be ultimately the test of the research job and of its applicability to practice.

Dental measures of various kinds must be tried out not only with small groups but on an increasingly large scale on the community as a whole. They must be tried out in school groups and in pre-school groups, and to some extent also among adults, to see how they work and what they cost. The trial must be for a sufficiently long period to judge results soundly. I hope that the generously coöperative attitude which the present Commissioner of Health of New York City has, with regard to dentistry, will make possible not only the development of increased service to the people, with the coöperation of the dental profession, but will stimulate also the development of what might be called laboratories in which the plans and methods worked out by the members of the profession in their various research enterprises, and in their practices, can be applied on an administratively important scale, and tested and judged both professionally and financially to see how far they shall go.

Surely one cannot but feel a great augury of hope in the present alignment of forces; that alignment of members of the dental and the medical professions working in coöperation with the organized health agencies of the community, headed by the Municipal Health Department, and backed, as we are sure they will be, by the newspapers and the private organizations in a common effort to solve this highly important health problem. We may hope that despite the stupendous size of the problem, increasing funds, increasing thought, and increasing understanding will flow to the program that you all have so much at heart.

William P. Healy, M.D. (*New York City*): Commissioner Harris and I have been going around a great deal together this winter and it has been a source of much pleasure to me. We have been attending a wonderful round of dinners, and I have had the opportunity of listening to a great many of his addresses. It has come to be a great question, at least in my mind, as to which one of us is going to "stick it out" longer. Sometimes I am reminded of the two Scotchmen who were in swimming. A man happened to come along and saw the Scotchmen in the water, and he said, "I will give a nickel to the fellow who will stay under water longer." They both drowned.

You have heard what the Commissioner said about what the Board of Apportionment is allowing the Department of Health this year in increased appropriations. It is only about half a million dollars. That is, I think, an indication that the Commissioner is, to say the least, no "piker," when he can go down and get half a million out. At the same time, I had no idea, until we heard his address this evening, that he was the real outstanding

buccaneer of the ages, because he has told us, without the slightest indication of fear, that he has made forty-five men walk the plank, and I think he is to be congratulated on the accomplishment. The medical profession feels that the Department of Health of New York City is infinitely better now than it was last spring, before Dr. Harris took it over. We are certainly very hopeful, and we have every reason to feel confident that our hope is not misplaced, that the Department of Health of this great city is again going to be in the van and not in the rear of medical work, not only in this country but in the world. As we here in America are given full credit by scientific visitors from abroad, as being distinctly in the lead in matters of sanitation, just in the same way, I have no doubt, it is readily admitted that we are distinctly in the lead in matters of dentistry. It was a great pleasure to me to receive the invitation from your President to come here this evening to meet you and to hear what Commissioner Harris might have to say.

I think possibly I have the distinction of placing before the New York County Medical Society one of the first important matters in dental education to come before it when I had a dental film shown at one of our meetings last spring, the title of which was: "Say it with pearls." The film was received with the closest attention and with the most complimentary remarks subsequently. I feel that the service of films is one of the important educational factors; it is one of the ways in which we are going to get education before the public. Incidentally, in my personal experience in matters of dental organization, it seems to me that the only occasions on which I was ever invited to meet with groups of dentists was always around election time, when some organizer, for one party or another, would try to organize the physicians, dentists, and pharmacists. We would all be invited to meet on matters of mutual interest which were, of course, only individual and personal interests and not at all community interests.

This program tonight is very much in line with another we are undoubtedly going to have this coming winter—a combined meeting of the New York County Medical Society and the First District Dental Society, when a program will be presented that will be of mutual interest to the two societies. There is no doubt in my mind that we have reached the time in our work when the two professions must plan to organize and endeavor to solve problems of mutual interest. We cannot do it as individuals in our profession, because our work is distinctly individualized. Your work is done in your own office. Ours is done within a small circle of patients. Therefore, when we try to solve problems of major interest we can only do it through our organized bodies. The New York Academy of Dentistry

affords one of your greatest opportunities to come here as individuals, and presenting your views to your Academy, and through your Academy endeavoring to have your problems solved, that is, the problems that bring you into touch with the community. Now, not every man is either able, or competent, or has the time to devote to public health matters. Therefore, he has to work of necessity through his organization, because in every organization there will be a small group of men who have the inclination, ability, and time to devote to matters of this kind. I believe this is one of the most important reasons for organizing as we do in our respective professions.

There is another matter which I think is of the utmost interest and value, now that *you* have fulfilled all the requirements for practicing your profession. You must guard the requirements demanded of those who wish to enter into your profession. These requirements must be maintained at the proper, normal standard, and the bars for admission to your profession must not be let down.

Dr. Davis gave a very interesting recital of his reaction to the problem presented by Commissioner Harris. Dr. Davis is an expert in working on dispensary and public health problems, and it is very interesting indeed, and I think you are very fortunate to have had the opportunity, to get his reaction to the problem of providing prophylactic, or some other form of dental treatment for the public, both for children and for adults, who may be benefited by such care. Of necessity, he views the problem from the administrative and financial aspect, that is, from the dispensary aspect, and he has to be very careful in his remarks, as you notice he was, not to say anything which would meet with too much opposition from the organized profession, the members of which might feel that there was to be some transgression upon their proper field of private practice. That is the same problem which we have to deal with in the dispensary work in medicine, the constant criticism from the men in practice that the dispensaries are treating patients who have no business to receive dispensary care.

It is a great pleasure, Mr. President, to have had the opportunity to come here and listen to Commissioner Harris and to meet the members of your Academy.

Henry W. Gillett, D.M.D., F.A.C.D. (*New York City*): Many of those present have heard me say, and perhaps some of you have heard me say repeatedly, that the dental profession has as yet barely scratched the surface of its field. I think those of you who have paid attention to Commis-

sioner Harris's address, and to the discussions that have been presented by Dr. Davis and Dr. Healy, have found confirmation of that statement.

There are many avenues into which we might wander in this discussion, but I shall try to keep rather closely to the line that has already been marked out. I have been convinced for a long time that the major problem of dentistry has ceased to be relief and cure of dental defects, but has become *prevention* of dental defects. Dentistry, as we have known it for the past decade or two, has steadily been growing less and less feasible for the "man in the street," and it has steadily become more and more important and valuable for the man who could command the necessary money to pay the fees for such dentistry. I see little hope for meeting the great need of reparative dental service for those with small incomes. I feel, however, there is great hope along the line of prevention, because there is no field of health service in which the beginnings of pathology can be more promptly or more easily detected, and in which they can be so completely eradicated, as in the dental field.

I made the statement, at a recent conference of representatives of several bodies interested in dental education, that dental educators are now prepared to so train dental students as to fit them to render service to the children who are placed early enough in their care, so that, if their insructions be followed, at least 50 per cent of all that the dentist now has to do for his patients would be prevented during the future lives of those children. I believe that statement may be made considerably stronger, but let's be conservative and leave it at 50 per cent. If eminent diagnosticians are correct in their findings, the reduction by 50 per cent of mouth pathology in children would automatically eliminate a considerable percentage of rheumatism, and gastro-intestinal, kidney, and heart disease. This would result in lessened demands upon our charity and relief organizations, and on our hospitals—and fewer weaklings and morons to populate our jails, prisons, reformatories, and asylums, and consequently for our police to cope with—a tremendous saving in dollars and an incalcuable saving in human comfort and happiness.

The man who probably would be rated as the dean of New York orthodontists, and who was here earlier in the evening, said in my hearing more than fifteen years ago that, if we could take every child when it began to masticate solid food and so train that child that it would naturally and by choice avoid the paps and porridges, the artificially softened foods, and select foods that require deliberate, forceful mastication, that one factor would eliminate 50 per cent of all that the orthodontists have to do. I believe that he would today endorse that statement.

At the risk of seeming tedious to some of you, I want to call to the Commissioner's attention certain facts in this particular field that are too frequently overlooked. The youth with pronounced malocclusion carries not only the handicaps of deformed features and an inefficient masticating organ, but also those of subnormal aeration due to abnormal air passages, and of constant nerve stress due to the cramping of the nerves and ganglia of the organs of special sense. Teeth are not "crowded" because they are too large, but because they fail to reach normal position and the alveolar process grew around them in such malpositions. Just as is the case with those subjects whose first permanent molars have been extracted by or before the age of ten (a misfortune rather common among the children of those with small incomes), the jaws remain stationary, but the rest of the organism grows. The maxilla articulates with nine other bones of the skull, and a ten year old maxilla in a twenty- or forty-year old head may, and frequently does, mean deformities of all the articulating bones as well as a malformed brain case. We think of cripples as those with deformed extremities and backs, but there are more crippled heads in our schools due to abnormal and diseased teeth than there are of all the other deformities combined and no one is thinking of them, or doing much to help them.

With regard to relief and care of the dental disease now rampant, gentlemen, if you took all the dentists of New York City off all other work and turned the school children over to them with instructions to relieve and properly treat all of the established pathology in the mouths of those children, they couldn't possibly keep up with the procession. Dentists have come to the conclusion that so far as dental service to school children is concerned, the only thing that is possible is to let the wave of already established disease go on, being content to do what little may be possible in the way of relief. They hold that the hope for the coming generations of children lies in prevention, in catching the child young enough so that the earliest stages of dental pathology may be discovered and may be checked. I sincerely believe that a program of that sort is possible, and I think the men who have made practical tests of that conception, who have tested that theory, also hold the same opinion. I believe that prevention of that type is possible, both physically and financially, and that the application of those principles will be a great saving. It has been demonstrated a number of times by different organizations that such a conception, adequately executed, will save enough in the school budget to pay its cost of reëducation of children. Commissioner Harris is undoubtedly familiar with the figures. It is something like forty or fifty dollars each, every time a child has to stay in a grade and go through that grade a second time, and a

great many children do not make the grade because they are suffering pain and physical disability that can be traced directly to mouth pathology.

Dr. Davis has mentioned a very important element of the situation. In a number of different localities, there have been demonstrations of the efficiency of preventive dental work for children at the earliest school age. There have been some attempts at preventive work in the pre-school ages. Enough evidence has been accumulated to convince those who are familiar with dentistry, and familiar with the results of such work, that those two ages are the worth-while ones for consideration. There is undoubtedly a need for the type of survey that Dr. Davis suggests. In my opinion there is no question that all the different factors he has enumerated, oral prophylaxis, operative procedure, nutritional studies, diet administration, and a number of other contributing factors, will be combined when we arrive at a conclusion that will satisfy us as a preventive program that shall adequately meet the situation. But the fact that the Commissioner of Health of New York City, that the County Medical Society, that the New York Tuberculosis and Health Association, that many organizations aligned with these important bodies, are beginning to grasp the needs of the case—the fact that our universities are beginning to realize that they have an important duty that has too long been neglected in preparing men to grasp and put into practice such a conception of preventive service as will be evolved from the conferences and experiences of these organizations—is all most hopeful. I am indeed happy to find myself, after having retired from active practice, still interested to look forward with optimism to the future of my profession, and I am glad to be able still to stand shoulder to shoulder with you on that platform and to tell Commissioner Harris how happy we are to find his position, one of insisting that dental service shall take its right place in the health service for the public.

President Bissell B. Palmer, Jr., D.D.S.: It may interest you to know that there is "no rest for the weary" in official life. Two of our guests of the evening, Commissioner Harris and Dr. Healy, are going from this meeting to a session at the Academy of Medicine, so that I think it would be inconsiderate for us to have a general discussion under these circumstances, and in consequence I am going to ask Commissioner Harris to close the discussion.

Dr. Harris (*in conclusion*): It has been a source of great satisfaction to hear the youthful, enthusiastic, and most optimistic viewpoint of Dr. Gillett. It heartens me. It makes me feel, in the light of what has been

said by a member of your own profession, that we have not far to go to find a statesmanlike viewpoint and to discover sources of technical help which will be of very considerable value and weight, especially since we number Dr. Gillett on our Dental Advisory Board in the Department of Health.

Earlier in the evening, I did not have a good defense of the soundness of the position that we were not justified at the present juncture to demand a substantial increase in our budget. I am now convinced of that, especially in the light of what Dr. Gillett said, and Dr. Davis stressed that quite emphatically, too. It is apparently urgently necessary to get a qualitative program, a program that, so far as quality and scope and the vision which animates it is concerned, will be adequate to the needs of the moment. In other words, we cannot go out and make a splurge. It is not desirable to spend large sums of money until we know what we are headed for. It is eminently necessary that the objectives, which were stressed by those who discussed the paper, be very clearly debated by the very gentlemen who joined in the discussion, as well as by those of your profession who have already manifested their willingness and desire to serve.

I think it takes so long sometimes to get a definite statement of what is going to be done. We are so fearful. We stand like those who would bathe, but just tentatively and fearfully put their toes into the water to feel how cold it is. They do not take the plunge. I am very frequently for taking the plunge, not because I am impetuous, not because I do not wish to be poised and balanced, but because debating too long reminds me of the dilemma that was pictured by Browning in the Statue and the Bust. You remember the lover who rode by, who looked and aspired, but dared not. The marble bust was quite as effective as he. Browning stated it far more eloquently, but that was the thought. The fact is, however, that we have a body of knowledge, as revealed by Dr. Gillett in the discussion, that ought to be enlisted in a concrete program. We have already sufficient knowledge to give the kind of qualitative test that will prove its value in a comparatively short time and warrant the further expansion of our work. I feel very much heartened. I hope you will not construe this as mere flattery, as the kind of thing that one perfunctorily says on occasions of this kind. I was very much cheered, particularly by what Dr. Gillett said, not because what the other discussers said was not equal to the point, but because coming from a member of the profession that you represent, coming from one who has laid down the arduous duties of professional daily practice—to find him with so clear a vision, so modern a viewpoint of what is essential—makes me feel that we need not wait long for that constructive action to follow that will warrant our undertaking

greater enterprises. It may be true that if all the dentists in the city were now to be diverted from their daily routine practice, and become engaged in the work of examining school children and dealing with the defects already existent, they could not meet the situation. Yet, we need not be discouraged by the largeness of the task, if we demonstrate, on a qualitative basis, the value of the program that has been indicated *tonight*, in some respects expressed in detail.

Dr. Davis spoke of the two to four dollars per capita, for our child population, that would be essential for necessary preventive and prophylactic work. Suppose it is? Why not announce a doctrine that, for the equivalent of what it costs to build a small torpedo boat, we may save human life. Why pussyfoot? I do not say that you did, but what I mean is, why not make the proclamation? Why not say fearlessly, that the sum involved for this City of New York is a beggarly sum, that millions are spent on things that, while they may be justifiable (I shall not engage in a broadside or in an attack upon anyone else), are not nearly so well justified as the preservation of life and health. Then why not become rather ambitious in our scheme of things? Why not talk ambitiously and plan ambitiously?

The Mayor, in a very beautiful speech that he made last night (which at least one who was present and is here tonight knows that I must call beautiful, because he indulged in tribute that I thought far beyond my deserts, but which was nevertheless beautiful and pleasing to me), said "We haven't a very expensive Health Commissioner." He doesn't know the half of it. I intend to be far more expensive in making demands upon the city exchequer. Why not, with ambitious schemes afoot and abroad in every way, demand the protection of human life? Of course, it is something that departs from tradition, from all past experience, when the Department of Health gets $400,000 in one year. But really I am not made dizzy by the gift. It seems splendid to me, only because it has broken the past tradition.

I have a tremendous respect for my fellow-commissioner, Commissioner McLaughlin. I know him as a man of honor and strength. I wish you knew him as well as I. In order that you will not think that I am disparaging his department and his efforts, I wish to say that I have a great admiration for him. But there was a great to do and a great squabble about the $400,000 that was to be apportioned for varied functions, by which human life was to be made safer, to be prolonged, and by which the inroads of disease were to be prevented. Then on the same afternoon, when I finished what was considered a very shameful raid upon the treasury of the city, an unabashed repetition of request after request, and I was nearly

told that I was brazen-faced, I found there wasn't anything like that argument over $4,000,000 increase in the budget that was voted for police protection. I do not minimize its value—do not misunderstand me, please—but I am rather ambitious to emulate that distinguished example. I am determined, with your aid and coöperation, that we shall not be satisfied with 10 per cent of the increase allotted to the Police Department when urgent problems of public health await us.

How many things are to be done with the $400,000 that was alloted to us? There is the reorganization of health education, in which you and I have a joint interest; the reorganization of public health nursing, which has been a branch of the service that has not been well integrated or well consolidated, which is not capable of mobilizing the tremendous force of nurses that we have, unlike the force possessed by any other locality. Under our command we have from eleven to sixteen hundred nurses, according to the season, a tremendous force to mobilize for various purposes and emergencies. Of the $400,000, $10,000 went for the reorganization of nursing service; $12,000 went for reconstruction, for the rehabilitation, of health education, which was most sorely needed, and virtually non-existent; and $25,000 for laboratory research. Do you see why I am impatient? I insist that we must revise, we must cut a larger pattern, and we will, if we make concrete the program of action indicated by Dr. Gillett and the other speakers, and fearlessly and boldly proclaim that anything less than that is a side-stepping of our duty and our moral obligation and our public trust. In that I hope you will join me.

This evening has been to me a most illuminating one. I am happy that I did stay for the discussion though I was most impatient to go to the Academy of Medicine, and I want to thank you most cordially for the very delightful opportunity to go back to my work with a clearer vision and a strong hope that you will help me to formulate a program, in a very short time, that will be constructive, aggressive, and that will give me the title and the claim and the warrant to demand large sums of money from a Board of Estimate that sees things on a small scale.

President Palmer: Several years ago, Dr. Mayo said that the next great step in preventive medicine must come from dentistry, and he wondered whether dentistry would make good that challenge. Tonight I think we have had no less vigorous a challenge from Commissioner Harris. I think that he has very definitely challenged us to recognize our responsibilities to public health. He stands by to do his part. If the Academy now wishes

to evidence our appreciation of his coming before us tonight, and to assure him that we pledge ourselves, as a profession and particularly as an organization, to support all the projects that he would like to see the dental profession accomplish in New York City, the members will indicate their feeling by a rising vote. [The Academy rose in a body to signify a unanimous Aye.—*Ed.*]

A CRITICAL REVIEW OF THE FINDINGS OF THE CALIFORNIA STOMATOLOGICAL RESEARCH GROUP[1]

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We have read with much interest the summary of researches in periodontia, during 1923–26, by the "California Stomatological Research Group,"[2] and take this opportunity to comment on their work. Comment seems to be justified by the importance of the subject of the researches and also by the fact that the work has had exceptional financial support,[3] including annual grants from the American Dental Association. The opportunity to conduct research extensively on inmates of the San Quentin Prison, with the coöperation of the Warden and the prisoners,[3] has aroused special expectation of practical achievement.[4] Because of the unusual opportunities the "California group" has enjoyed, we hoped for announcements which would indicate that great advances had been made in the field. While we admire the conscientious efforts which have so evidently been put forth in this work, we must confess to a feeling of disappointment in the results as announced. The following comments are offered not in a spirit of carping criticism, but because we believe that the dental profession is entitled to such an evaluation of this work as lies within the ability of various members of the profession to set forth.

The report covers a number of headings and it is evident, from the

[1] Constructive evaluation of the findings of research serves a useful public purpose. This review was written in response to invitations from members of the Board of Editors. —[*Ed.*]

[2] Simonton: *Journal of Dental Research*, 1926, vi, p. 163.

[3] Gies: Dental education in the United States and Canada, 1926, pp. 270 and 272; Bulletin Number Nineteen of the Carnegie Foundation for the Advancement of Teaching, New York.

[4] In the summary of the work of the California group there appear to be only two references to the prisoners at San Quentin.

items enumerated, that in some of the fields chosen a very considerable amount of work has been done, much of which has a negative value. This work is not on that account to be deprecated, since it may prove to have value of a sort in a general research program. We cannot but regret, however, that there seems in this report to be so little of positive value to supplement these negative findings.

The subjects of bacteriology and protozoology are given approximately half of the space utilized in the report. Many points are brought out which conceivably have a bearing on the subject of periodontal disease. It appears that practically all of these findings have a negative value, and tend to confirm earlier theories in this field, although many of the results are stated as being "new findings." Since the cultural methods seem to have been essentially those pursued in earlier efforts in this field, confirmation was to have been expected. We feel that under the circumstances a disproportionate amount of time and effort has been expended on this phase of the problem. It would seem necessary that, for progress, a field presenting so many complexities and difficulties must be investigated through the medium of cultural methods yet to be developed.

The subject of histopathology occupies about one page of the report. The title of this section is not quite accurate, inasmuch as most of the recorded findings deal with the subject of the activity of bacteria in the tissues involved. But little attention seems to have been paid to morphological changes in these tissues and the interpretation of these changes. The work of such eminent pathologists as Gottlieb and Box indicates the tremendous importance of studying periodontal disease from this standpoint. It is evident from their work that the field of histopathology is one of the richest single fields in periodontal research.

The subject of nutrition has been attacked in a broad way, and the section devoted to work in this field shows perhaps the most valuable observations in the entire report. As is so frequently the case in nutrition experiments, there seems to have been a tendency to push dietary disbalance to an extreme in the effort to produce appreciable tissue changes in the animals employed in the experiment. This practice results frequently in such profound changes as nearly to remove the experiment from the field of practical application. It is doubtless

true that malnutrition, in its various aspects, has something to do with susceptibility to periodontal disease. The reports of McCollum, Howe, and others indicate this very definitely. On the other hand, no one has shown positive success in the treatment of periodontal disease through dietary improvement. It is also noteworthy that striking clinical success has been attained in the treatment of such disease, with slight if any attention to dietary factors. We emphasize this point because of the statement made in the general deductions that "the *practice* of periodontia in the future will be concerned with the diet of the patient." There is nothing in the report, not even under the heading of "nutrition" in the Addendum, which would warrant the drawing of such a conclusion.

The section on dental studies may be considered under two headings. The first deals with comparative observations on Mexicans and whites, as to certain dental peculiarities and regarding the incidence of periodontal disease. Since no statement is made that Mexicans are unusually susceptible to periodontoclasia, as are for instance the Chinese, the purpose of this study is not clear. The second division of the dental studies may be analyzed as a restatement of methods of examination and treatment previously advocated but not widely accepted by dentists of broad clinical experience.

The section on "medical studies" might well be passed without comment. Individuals of the age of the average dental student present so slight a degree of periodontal disease that studies in this age group are unlikely to yield results of value. Such cases of disease as may occur are not typical, assuming that there is such a thing as typical periodontal disease. In fact periodontal disease, being evidently so much under the control of local factors of extremely variable distribution, does not lend itself to percentage calculations except as these may be based on very exact studies of very large groups. Therefore, a study of fourteen individuals of whatever age, even if suffering from advanced periodontal disease, could furnish no reliable findings. The findings on focal infection are not original, although their restatement may have value in this subject, which is still a centre of controversy.

The section on "evolution" is very brief. We question the wisdom of the use of the word "evolution" in this connection. It is capable

of more than one interpretation. If reference is made to changes in individuals which are traceable to the influence of heredity and environment, we feel that a more exact basis for observation is offered. We feel that these factors have a very definite influence as regards the inception and course of periodontal disease.

In the Addendum, under the heading of "nutrition," experiments have been performed looking toward the derivation of information regarding the factors which influence the excretion of various mineral elements from the body. The findings as reported are not made to appear as having any obvious clinical significance. That a connection between mineral metabolism and susceptibility to periodontal disease may exist, is within the range of possibility, but this connection is not brought out in the report.

The section on "localization of pyorrheal involvements" is disappointing in that it indicates a lack of thorough appreciation of certain local factors well known to many specialists in this field. The first item in this section (*109), is marked with an asterisk, indicating the claim of originality. We agree that local factors are influential and also that many mouths remain healthy in spite of the existence of local factors capable of initiating periodontal lesions. But, this observation is neither new nor original. It has been stated by numerous writers. The attempt to demonstrate susceptibility by means of graphs indicates a lack of realization of the ungoverned variability of local factors. There is no bilateral symmetry or asymmetry in the placement of the teeth in the arches comparable to the bilateral symmetry of structural forms and defects in the teeth themselves.

In item *112, the statement is made that "abnormal occlusal stresses are not sufficient in themselves to account for the localizations which occur." Further statements are made which indicate an effort to draw conclusions from a tabulation of the surfaces of teeth affected by lesions and the location of teeth so involved. The very effort proves conclusively a lack of understanding of the mechanism through which traumatic occlusion acts as an initiating factor in this disease. In the first place traumatic occlusion does not, in itself, produce pus-pockets. Other interacting factors must supplement the action of this agency. Only when there is concerted action of these agencies, in which we include as prominent the items of pathogenic bacteria, cal-

culus, and local resistance, do we have the formation of the typical pus-pocket. When to this possibility of variation we add the extremely varied mal-positions of teeth in different mouths, and in different parts of the same mouth, we recognize at once the futility of drawing conclusions from graphs, whose basis is the assumption of a constant factor as regards corresponding teeth.

Attention should be drawn to one feature of the report which deserves commendation. In the section on histopathology, mention is made of studies on the experimental production of injuries to dental tissues in the guinea pig, rabbit, cat, and dog, which are in progress. While the dentition of the guinea pig and rabbit offers no likelihood of developing periodontal disease analogous to that of the human, and while experiments on these animals seem therefore to have no probable value, experiments on the cat and dog should yield brilliant results. It seems strange that so fruitful a field should have been neglected for so long a time as is indicated by the fact that these experiments are only now "in progress" (1926).

The "general deductions" are so very *general* that, even if accepted as truths, they furnish no basis for the formulation of theories, nor do they permit of specific application in practice. Not only is there disappointment in this, but there is disappointment also in the evident failure to utilize, as a basis of research, the rather voluminous material available, resulting from acknowledged clinical success in treatment. Many practitioners of today are securing splendid health results in the treatment of even advanced cases of periodontoclasia. A system capable of yielding such consistent results must contain within itself the germs of truth. To seek out these germs, bring them to light, and explain their biological foundation, should be the first step in research intended further to advance the control of this disease.

We looked for a statement regarding histological studies of teeth showing reattachment of gingival tissue after treatment of periodontoclasia, understanding from earlier reports that success in this field had been achieved. We regret that this evidence is not presented.

In conclusion, we would say that this research taken as a whole fails to advance measurably our knowledge of periodontal disease as regards its control in practice. We regret to say that it seems to demonstrate the lack of a clear vision of the essential nature of the problem, and of

the necessities concerned in its solution. We wish to commend the California Stomatological Research Group and especially Dr. Simonton for the initiative and effort which has been demonstrated in the conduct of these experiments. Some of the work which has been done is unquestionably needed for the rounding out of comprehensive research in this field. The painstaking manner in which it has been performed seems to assure the dental profession that the experiments which have been completed will not need repetition. What is most gratifying is the evidence adduced that the spirit of research is abroad in the land.

THE ERUPTION OF DECIDUOUS TEETH AMONG HEBREW INFANTS[1]

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I am indebted to Dr. Alfred F. Hess for permission to collect observations on the eruption of deciduous teeth among children in the Home for Hebrew Infants, New York City. The children were observed at intervals of three months by Dr. Louis N. Sullivan and Mr. Maynard, and the gradual changes in the set of deciduous teeth were recorded on a sheet providing for a sufficient number of repeated observations. The teeth were recorded as absent, erupting or fully erupted. On the record sheet dates of birth and dates of observation were recorded. The age at the time of eruption was assumed as the middle date between the last date of absence of a tooth and the first date of its full presence. In cases of an erupting tooth, twenty days were added to the date of the observation when eruption was recorded. Undoubtedly the method entails errors in the exact dating of eruption, but since our tables show that the variability of eruption is considerable, the error is probably negligible, since it does not seem likely that the assumption of evenly distributed eruption during the whole interval entails a constant error. The cases in which a tooth was recorded as erupting are not many and do not appreciably influence the distribution of observations.

Tables 1 and *2* show the observed time of eruption for each tooth. Columns I and II indicate the inner and outer incisors, III the canines, IV and V the deciduous molars.

Tables 3 and *4* give the frequency of occurrence of each deciduous tooth among all the children of a given age. By this method a much larger number of children may be included in the tabulation than by the preceding method. Averages and variabilities, given in these

[1] A preliminary note, on "the growth of children as influenced by environmental and hereditary conditions," was published in *School and Society* (1923, xvii, p. 305).

TABLE 1

Eruption of teeth in boys

AGE IN MONTHS*	UPPER TEETH					LOWER TEETH				
	I	II	III	IV	V	I	II	III	IV	V
4	—	—	—	—	—	1	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	2	—	—	—	—
8	1	—	—	—	—	—	1	—	—	—
9	1	—	—	—	—	2	1	—	—	—
10	5	3	—	—	—	5	1	—	—	—
11	6	3	—	—	—	5	2	—	—	—
12	3	3	—	—	—	3	2	—	—	—
13	7	2	1	—	—	4	1	1	—	—
14	3	5	2	3	—	3	5	2	2	—
15	1	2	1	—	—	—	2	2	1	—
16	—	4	1	1	—	—	2	1	—	—
17	3	5	1	6	—	—	7	1	6	—
18	1	4	8	6	1	3	4	8	7	1
19	—	5	3	7	—	—	1	1	8	—
20	—	3	12	6	1	—	1	12	8	—
21	—	—	3	6	1	—	1	2	2	1
22	1	1	5	5	1	—	2	6	6	2
23	—	—	6	2	3	—	—	6	2	3
24	—	1	2	1	3	—	—	3	—	5
25	—	—	7	—	9	—	—	6	1	9
26	—	—	5	3	1	—	1	4	—	3
27	—	—	1	—	4	—	—	1	1	4
28	—	—	1	1	3	—	—	1	2	3
29	—	—	—	—	8	—	—	1	—	7
30	—	—	1	—	4	—	1	1	—	3
31	—	—	2	—	1	—	—	—	—	1
32	—	—	—	—	2	—	—	—	—	3
33	—	—	1	—	5	—	—	—	—	4
34	—	—	—	—	1	—	—	1	—	1
35	—	—	—	—	2	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—
37	—	—	—	—	—	—	—	—	—	—
38	—	—	—	—	—	—	—	—	—	—
39	—	—	—	—	2	—	—	—	—	1
40	—	—	—	—	—	—	—	—	—	1
41	—	—	—	—	—	—	—	—	—	—
42	—	—	—	—	—	—	—	—	—	—
43	—	—	—	—	—	—	—	—	—	—
44	—	—	—	—	1	—	—	—	—	—
Cases.....	32	40	63	47	53	28	35	60	46	52
Average.....	13.3	16.6	22.3	20.3	28.9	12.1	16.8	22.0	20.3	28.0
Standard deviation...	±3.0	±3.4	±4.1	±3.0	±4.9	±3.1	±4.5	±4.1	±3.0	±4.2

* Each month includes the ages from the beginning to the end of the month. The average age for 4 or 5 months is, therefore, 4.5 or 5.5.

tables, have been determined from the percentage series directly. *Table 5* contains a summary of the averages and variabilities given in the preceding four tables.

The results obtained by direct observation of the eruption of each

TABLE 2

Eruption of teeth in girls

AGE IN MONTHS	UPPER TEETH					LOWER TEETH				
	I	II	III	IV	V	I	II	III	IV	V
4	1	—	—	—	—	1	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	2	—	—	—	—
8	2	1	—	—	—	—	2	—	—	—
9	2	—	—	—	—	5	—	—	—	—
10	2	—	—	—	—	4	—	—	—	—
11	1	1	—	—	—	—	—	—	—	—
12	2	5	—	—	—	2	2	—	—	—
13	2	1	1	1	—	—	1	1	1	—
14	3	2	1	1	1	2	1	—	—	1
15	1	—	2	3	—	—	1	2	3	—
16	1	3	—	2	—	—	4	—	2	—
17	—	5	2	2	—	—	3	—	2	—
18	—	4	3	3	—	—	2	2	3	—
19	2	2	2	2	—	1	1	3	1	—
20	—	—	—	5	—	—	1	1	2	—
21	—	—	8	6	1	—	1	7	5	1
22	1	1	4	3	1	—	—	3	—	1
23	1	—	—	—	1	—	—	—	—	1
24	—	—	5	3	3	—	—	4	2	5
25	—	—	3	—	2	—	—	3	1	3
26	—	1	—	1	2	—	—	—	—	2
27	—	—	—	—	2	—	—	—	1	2
28	—	1	—	1	3	—	—	—	—	3
29	—	—	1	—	3	—	—	1	1	2
30	—	—	—	—	3	—	—	—	—	3
31	—	—	1	—	2	—	—	1	—	1
32	—	—	—	—	2	—	—	—	—	2
33	—	—	1	—	3	—	—	1	—	1
Cases.....	21	27	34	33	30	17	19	29	24	29
Average.....	13.6	16.8	21.9	20.1	28.6	10.7	15.9	22.3	20.1	27.9
Standard deviation...	±4.7	±4.4	±4.4	±3.4	±4.9	±3.3	±3.5	±4.3	±3.9	±6.0

TABLE 3

Number of boys (in per cent) that have erupted deciduous teeth

(748 observations)

CASES		UPPER TEETH					LOWER TEETH				
Age in months	Number	I	II	III	IV	V	I	II	III	IV	V
7	11	9	9	0	0	0	9	9	0	0	0
8	15	7	0	0	0	0	13	0	0	0	0
9	12	8	0	0	0	0	67	0	0	0	0
10	15	20	13	0	0	0	33	13	0	0	0
11	16	37	19	0	0	0	81	6	0	0	0
12	9	77	22	0	0	0	89	11	0	0	0
13	19	63	37	5	5	5	84	32	5	5	5
14	12	75	50	0	8	0	92	3	0	0	0
15	13	92	38	15	0	0	100	38	8	0	0
16	20	90	70	25	35	0	90	65	20	25	0
17	18	88	72	33	33	0	89	67	22	44	0
18	13	100	92	8	31	0	100	85	8	33	0
19	30	100	97	57	70	3	100	96	43	60	3
20	20	100	90	50	75	10	100	80	60	80	5
21	20	100	100	65	90	10	100	95	55	85	10
22	30	100	97	73	97	10	100	93	67	97	10
23	27	100	100	74	89	17	100	96	78	89	22
24	13	100	100	92	100	8	100	100	85	100	8
25	21	100	100	81	95	29	100	95	76	100	29
26	32	100	100	91	97	50	100	94	91	97	53
27	16	100	100	100	100	31	100	100	88	94	44
28	19	100	100	95	100	58	100	100	90	100	53
29	28	100	100	89	100	68	100	96	89	96	68
30	20	100	100	100	100	75	100	100	100	95	75
31	26	100	100	96	100	77	100	100	100	100	81
32	28	100	100	96	100	71	100	100	100	100	78
33	26	100	100	96	100	92	100	100	96	100	92
34	21	100	100	100	100	95	100	100	100	100	100
35	17	100	100	100	100	100	100	100	100	100	100
36	26	100	100	100	100	88	100	100	100	100	88
37	22	100	100	100	100	91	100	100	100	100	95
38	15	100	100	100	100	93	100	100	100	100	91
39	24	100	100	100	100	100	100	100	100	100	100
40	24	100	100	100	100	100	100	100	100	100	100
41	16	100	100	100	100	100	100	100	100	100	100
42	25	100	100	100	100	96	100	100	100	100	100
43	29	100	100	100	100	100	100	100	100	100	100
Averages.....		12.8	15.4	21.1	19.2	28.7	11.0	16.8	21.7	19.5	28.4
Standard deviation.....		±2.8	±3.4	±4.5	±2.9	±5.1	±2.8	±4.0	±4.5	±3.1	±4.8

TABLE 4

Number of girls (in per cent) that have erupted deciduous teeth

(419 observations)

CASES		UPPER TEETH					LOWER TEETH				
Age in months	Number	I	II	III	IV	V	I	II	III	IV	V
7	9	0	0	0	0	0	11	0	0	0	0
8	11	0	0	0	0	0	9	0	0	0	0
9	6	17	33	17	17	0	50	17	17	17	0
10	9	33	11	0	0	0	78	11	0	0	0
11	11	27	17	0	0	0	64	0	0	0	0
12	7	43	14	0	0	0	83	17	0	0	0
13	6	23	67	17	17	0	83	33	17	17	0
14	12	75	58	8	8	0	92	33	0	8	0
15	7	86	57	14	28	0	100	71	28	28	0
16	12	100	58	17	25	8	100	50	17	25	8
17	8	87	75	12	25	0	75	75	12	25	0
18	14	93	93	21	35	0	100	71	14	36	0
19	14	100	100	27	64	14	100	93	28	64	14
20	11	100	100	45	55	0	100	82	36	54	0
21	17	94	88	41	71	12	100	82	65	65	12
22	12	100	100	42	92	4	100	92	42	83	8
23	10	100	100	70	100	10	100	90	70	90	20
24	18	100	88	72	89	17	100	94	67	83	17
25	9	100	100	89	100	55	100	100	100	100	55
26	15	100	100	100	100	47	100	100	100	100	53
27	19	100	94	89	95	33	100	100	95	98	31
28	13	100	100	92	92	46	100	100	92	92	46
29	14	100	100	93	100	64	100	100	93	100	64
30	15	100	100	93	100	67	100	100	93	100	67
31	18	100	100	100	100	78	100	100	100	100	82
32	19	100	100	100	100	89	100	100	100	100	95
33	18	100	100	100	100	95	100	100	100	100	94
34	17	100	100	100	100	94	100	100	100	100	94
35	17	100	100	100	100	95	100	100	100	100	94
36	11	100	100	100	100	100	100	100	100	100	100
37	17	100	100	100	100	94	100	100	100	100	94
38	18	100	100	100	100	94	100	100	100	100	94
39	5	100	100	100	100	100	100	100	100	100	100
Average.....		13.5	15.0	21.9	19.4	28.5	11.0	16.4	21.6	19.6	28.1
Standard deviation.....		±3.1	±3.5	±5.1	±4.2	±4.8	±3.0	±4.3	±4.9	±4.4	±4.9

TABLE 5

Average age in months at time of eruption of deciduous teeth, calculated from observations of eruption

	I	II	III	IV	V
Boys					
Number of cases	32	40	63	47	53
(1) Upper jaw	13.3±3.0	16.6±3.4	22.3±4.1	20.3±3.0	28.9±4.9
Number of cases	28	35	60	46	52
(2) Lower jaw	12.1±3.1	16.8±4.5	22.0±4.1	20.3±3.0	28.0±4.2
Girls					
Number of cases	21	27	34	33	30
(3) Upper jaw	13.6±4.7	16.8±4.4	21.9±4.4	20.1±3.4	28.6±4.9
Number of cases	17	19	29	24	29
(4) Lower jaw	10.7±3.3	15.9±3.5	22.3±4.3	20.1±3.9	27.9±6.0
Calculated from observations of presence of teeth at given ages					
Boys					
(5) Upper jaw	12.8±2.8	15.4±3.4	21.1±4.5	19.2±2.9	28.7±5.1
(6) Lower jaw	11.0±2.8	16.8±4.0	21.7±4.5	19.5±3.1	28.4±4.8
Girls					
(7) Upper jaw	13.5±3.1	15.0±3.5	21.8±5.1	19.4±4.2	28.5±4.8
(8) Lower jaw	11.0±3.0	16.4±4.3	21.6±4.9	19.6±4.4	28.1±4.9

TABLE 6

Differences in time (months) of eruption as calculated from observations of eruption and from observations of presence of tooth at given ages

	I	II	III	IV	V
Boys					
Upper jaw (1–5)*	−0.5	−1.2	−1.2	−1.1	−0.2
Lower jaw (2–6)	−1.1	±0.0	−0.3	−0.8	0.4
Girls					
Upper jaw (3–7)	−0.1	−1.8	0.0	−0.7	−0.1
Lower jaw (5–8)	0.3	0.5	−0.7	−0.5	0.2

* The numerals in parentheses indicate the lines in *Table 5* which have been compared.

tooth and those obtained from the observation of presence or absence of the tooth at given ages are not identical. In *Table 6* the differences between the two series are given.

It appears from this table that the age at the time of eruption of the

TABLE 7

Weights of boys in the Home for Hebrew Infants compared with the general average weights of American children

I. Age (months)
II. Number of cases observed in the Home
III. Average weight of children in the Home (pounds)
IV. General average weight of American children
V. Weight of children in the Home, minus general average weight. (Negative values in favor of general average; positive values in favor of Home average)

I	II	III	IV	V	I	II	III	IV	V
5	4	13.0	16.6	−3.6	34	11	30.7	30.1	+0.6
6	9	13.2	17.5	−4.3	35	13	32.2	30.5	+1.7
7	4	12.9	18.3	−5.4	36	18	31.7	30.8	+0.9
8	10	14.6	19.0	−4.4	37	13	30.8	31.0	−0.2
9	11	16.4	19.4	−3.0	38	6	31.7	31.2	+0.5
10	10	16.0	20.1	−4.1	39	16	32.1	31.6	+0.5
11	13	17.6	20.7	−3.1	40	14	32.7	32.0	+0.7
12	5	18.8	21.2	−2.4	41	7	31.5	32.4	−0.9
13	12	18.5	21.7	−3.2	42	18	33.3	32.8	+0.5
14	8	19.6	22.2	−2.6	43	16	33.4	33.2	+0.2
15	11	20.9	22.4	−1.5	44	11	33.5	33.3	+0.2
16	15	21.4	23.1	−1.7	45	6	34.3	33.9	+0.4
17	15	23.0	23.6	−0.6	46	23	35.0	34.1	+0.9
18	7	23.2	24.2	−1.0	47	8	35.2	34.2	+1.0
19	28	23.2	24.7	−1.5	48	4	37.0	34.4	+2.6
20	16	25.1	24.9	+0.2	49	22	36.0	34.6	+1.4
21	16	24.0	25.3	−1.3	50	13	36.3	35.0	+1.3
22	23	25.0	25.8	−0.8	51	8	34.8	35.1	−0.3
23	21	25.9	26.0	−0.1	52	21	37.4	35.3	+2.1
24	11	26.5	26.5	±0.0	53	14	37.4	35.8	+1.6
25	16	25.6	27.0	−1.4	54	11	35.7	36.0	−0.3
26	28	26.7	27.2	−0.5	55	17	37.9	36.4	+1.5
27	11	27.9	27.5	+0.4	56	20	38.5	36.9	+1.6
28	13	26.1	27.8	−1.7	57	8	36.6	37.0	−0.4
29	22	28.2	28.4	−0.2	58	11	38.8	37.4	+1.4
30	14	29.0	28.9	+0.1	59	21	41.0	37.8	+3.2
31	17	28.4	29.2	−0.8	60	13	39.5	38.0	+1.5
32	21	29.6	29.7	−0.1	61	6	40.7	38.5	+2.2
33	14	29.4	29.9	−0.5	62	12	41.2	39.1	+2.1

TABLE 8

Difference in time (months) of eruption of the teeth of the upper and lower jaws

	I	II	III	IV	V
Boys (1–2)*	1.2	−0.2	0.3	0.0	0.9
Boys (5–6)	1.8	−1.4	−0.6	−0.3	0.3
Girls (3–4)	2.9	0.9	−0.4	0.0	0.7
Girls (7–8)	2.5	−1.4	0.3	−0.2	0.4

* The numerals in parenthesis indicate the lines in *Table 5* which have been compared.

TABLE 9

Differences in time (months) of eruption of teeth for boys and girls

	I	II	III	IV	V
Upper jaw (1–3)*	−0.3	−0.2	0.4	0.2	0.3
Upper jaw (5–7)	−0.7	0.4	−0.8	−0.2	0.2
Lower jaw (2–4)	1.4	0.9	−0.3	0.2	0.1
Lower jaw (6–8)	0.0	0.4	0.1	−0.1	0.3

* The numerals in parenthesis indicate the lines in *Table 5* which have been compared.

teeth in the second series is throughout earlier than in the former series. The series of observations in which only the presence or absence of the tooth was noted contains many children who were just about to be discharged from the Infant Home, while those in which the actual eruption was observed were mostly children who stayed in the Home for a long time. It may, therefore, be that the two series represent different health conditions and that this may account for the difference in time of eruption.

Although our information in regard to the time of eruption of teeth is not by any means adequate, it seems that the Home children are very much retarded in the eruption of deciduous teeth, particularly of the lower inner incisors. It seems possible that this is due to the poor condition in which most of the children are when taken to the Home.

For an understanding of this phenomenon, the general development of the children at the Home is of interest. The weights of the children have been compared with those of the average American children as recorded by Dr. Woodbury. *Table 7* contains the results of this comparison. It will be seen that all the very young children are de-

cidedly inferior to the average run of American children. From 34 months on, however, the Home children exceed almost regularly in weight the average American children, and the differences increase with age. Although the exact data in regard to the length of stay of children in the Infant Home have not been recorded on our charts, it is evident that the older children are those who have been in the charge of the Home for a longer period, and we may safely infer that the care given to them in this institution accelerates their development in weight. The observations of the teeth, on the other hand, show that notwithstanding this acceleration, the dental development remains considerably retarded.

Table 8 gives a comparison of the average age at the time of eruption of the teeth of the upper and lower jaws. It will be noted that for the inner incisor there is the well known characteristic difference in favor of the lower jaw. There is also a slight difference in favor of the lower jaw in the case of the second deciduous molar. For all the other teeth the differences are very slight. It seems likely that the outer incisor of the upper jaw precedes slightly in eruption the corresponding tooth of the lower jaw.

Table 9 gives the differences in the time of eruption of teeth for boys and girls. It will be noted that the differences are almost always slight and irregularly distributed, so that it would seem that there is no characteristic sex difference in the time of eruption for these children. Only in the second deciduous molar, the one latest to erupt, do we find a consistent delay for the boys as compared to the girls. This corresponds with the general observation that the physical acceleration of girls increases rapidly during the first few years of life.

The variability of the time of eruption increases with the absolute time of eruption. The variability is least for the inner incisor, and reaches its maximum for the second deciduous molar.

THE DIAGNOSIS OF INCIPIENT METASTASIS, AND OF DIFFERENT PHASES OF MALNUTRITION, BY MEANS OF VARIATIONS IN THE APPEARANCE OF THE DENTAL TISSUES[1]

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The hands on the dial of a watch indicate the time. The needle on an ammeter indicates the amount of amperage. When a battery in an automobile becomes short-circuited, a delicate needle at once indicates that the battery is discharging. These are samples of the diagnostic aids science has devised in our industrial life. In this respect man has followed in the footsteps of nature. When disease attacks a beautiful tree and the nutritional quality of the sap deteriorates, nature at once displays its indicator. The last budlet on the outermost branch dies almost at birth. This is the first indication that something has gone wrong with the tree.

Medical science teems with aids to diagnosis of the etiology of disease. Too often, however, the diagnosis has been made too late to be of much value to the patient. Consequently we are hearing more today about the value of an early diagnosis of disease.

During this winter (1924–25) prominent specialists, under the auspices of a joint committee of the Academy of Medicine and the County Medical Societies, have been giving weekly lectures regarding the aid to be obtained in a specialty outside of the conventional methods in common use. Every specialty was represented except dentistry, although, just as the death of the outermost budlet represents the beginning of disease, so also the gums, nourished by the ultimate capillaries of what I believe to be the longest capillary system, display the first indication of the beginning of disease. When this great omission in these very valuable lectures was called to the attention

[1] Read at a meeting of the Pathodontia Section of the First District Dental Society of the State of New York, New York Academy of Medicine, March 16, 1925.

of the Committee, a very polite reply was received that this would be rectified next year by a lecture on mouth hygiene. That the chairman's attention was being called to the fact that the gums were beyond all question the first index of incipient disease, and that he utterly failed to comprehend this, illustrates the paradoxical relationship that still exists between medicine and dentistry. Here are two bodies of men devoting themselves to the sacred occupation of ministering to the ills of man, the physicians starting to practice without any proper education regarding the dental organs, and the large majority of dentists treating disease involving the circulation without a thorough education in every form of pathology.

Let us assume as a working hypothesis that every condition of systemic disease produces certain changes of the dental tissues, and then let us inquire to what extent the recognition of such changes can in turn be utilized in the diagnosis of the conditions of systemic disease. If the medical curriculum embraced a proper course on the principles of dentistry, early diagnosis of different types of metastasis and malnutrition would be a reality, and not as it is something very much to be desired. Variations in the color, consistency, shape, and character of the gums, pericementum, glands and excretion, are as numerous as the diseases which attack the body. The very important point is that each disease has its own indicator, which can be read by the discriminating scientific observer.

In order to be able first to observe and then to interpret all kinds of abnormalities, it is essential that one should know a physiologic mouth under all conditions. As the etiologic factor (whether some form of mal-nutrition or something else) becomes more marked, unless delayed by ideal, home, mouth prophylaxis, the mouth symptoms become more marked, and finally a stage of local depreciation is reached where infection of the gingiva takes place, and periodontoclasia begins. This pyorrhetic condition increases in severity and keeps pace with the status of the constitutional derangement. There may be present a gingivitis of a more or less severe type owing to a lack of proper mouth hygiene, together with or without localized irritation, and with no apparent systemic disease. Simple surgical intervention and proper attention to mouth hygiene readily cure the worst kind of such cases. A stage of periclasia is never reached. True periodonto-

clasia, however, is invariably the localized manifestation of something wrong in the blood stream. It may be a metastasis, or a toxemia, or some form of malnutrition. It can, however, be safely asserted that true periclasia is never found in the mouth of a normal healthy individual. Whenever a case has been presented where it is claimed that the patient is in good health, it means that the nature of the constitutional derangement has not been diagnosed.

In 1894 I presented to the American Dental Association a classification of periclasia based upon these facts. This classification holds good today, and cannot fail to be accepted by the logical mind of the trained expert pathologist. It will be impossible to discuss the diagnostic indicators of every type of disease because the field is too large and affords much material for further study. Your attention is called to a few important illustrations that confirm the correctness of our observations.

For over a century the bluish tingeing of the gums has been recognized in medicine as diagnostic of mercurial poisoning.[2] With the universal acceptance by the medical world of this fact, it is strange that this indication in diagnosis has not been followed up.

Tuberculosis of the lungs is a wasting disease in the course of which the strength and vitality gradually passes away. As the disease progresses, one of the most distressing of the symptoms is the night sweat of the patient. He awakens drenched by perspiration. The mucous follicles in the gums, so well described by the late Professor Black are analogous, in their eliminating properties, to the sweat glands in the derma. In a state of health and repose these glands are not apparent. They may be temporarily excited into a state of activity, but any continuous excretory action of these glands is a positive indication of some departure from normality. Just as soon as the apex of the lung is wounded by the tubercle bacillus, the mucous follicles, in accordance with my observations, excrete visible amounts of fluid, before the action of the sweat glands attracts attention. This excretory stream increases in amount in proportion to the increase in the invasion of the lung tissue. The character of the excretion varies also according to the type of tuberculosis. In the very slow

[2] A similar effect—the "lead line"—may result from lead poisoning.

invasion of the lung the excretion is very watery, while in miliary tuberculosis the excretion is a very thick mucous. If, when the tuberculosis is in an active state, the upper lip is raised, the fluid will be seen to spurt from the gums, often like a series of miniature fountains.

That the mucous follicle is a valuable diagnostic factor is not new in dentistry. It has long been the custom to diagnose acidosis by placing strips of blue-litmus paper under the lip and observing the pink spots on the blue paper in cases of acidity.

In the old chronic cases of phthisis, where the emaciation becomes so marked that the individual is called a living skeleton, the mucous follicles themselves frequently are destroyed and the gum becomes very much attenuated—at the neck of the tooth it is as thin as tissue paper, appearing as though planed by a microtome.

Any interference with the normal action of the digestive tract, whether due to an imperfectly balanced diet or to some toxic agent, is shown at once by the indicator. The common canker sore, caused by digestive derangement, is a good illustration.

From this we pass to the more serious toxic influences in the digestive tract, of which poisoning by bacterial toxins (formerly spoken of as ptomaine toxemia) is a good example. In such cases a degree of stomatitis starts up, the severity of which is dependent upon the nature and activity of the toxin. The pyorrhetic condition of the mouths of sailors in extreme latitudes, who lack the proper amounts of vitamins in their food, has been graphically described.

Forty years ago infantile scorbutus was not known to the internist, but children by the score died in great agony from this condition of virtual starvation. "Died from rheumatism" was the physician's inscription on the death certificate. Never have I seen such a terrible destruction of dental tissues as I saw in those days. The following case cited by me in a discussion of a paper by E. C. Kirk, on "Infantile scorbutus," should be very enlightening:

In 1886 a physician and his wife brought me their baby, eighteen months old, for consultation. They informed me the child had rheumatism and was in constant agony, and they wanted to know what I could do to relieve the great suffering from the exposed pulps in the four upper incisors. The enamel of these teeth was almost entirely

destroyed. The incisal portions had decayed so that the pulps of all four teeth were protruding. Pus was literally pouring from the gingiva of all the teeth. The gums were soft, ruby red, inflamed, and bled at the slightest touch. The oral condition so closely resembled the graphic description of scurvy, of which I had read, that I immediately had a conviction that here was a baby with scurvy. At least an hour was consumed in carefully investigating the history of mother, father, and baby, leaving the dietary question for the very last. The child from birth had been brought up on a preparation called "Swiss Prepared Cream." Although only in practice for five years, I was bold enough to hold out hopes of recovery, if they would throw away this imported cream. My directions were carried out. Carefully prepared cow's milk was substituted; orange juice was given at the start four times a day. Soon after, a little barley gruel was introduced, and though we knew nothing of vitamins, a spoonful of cod-liver oil daily was shortly added to his diet. At that time cod-liver oil was empirically prescribed for children generally, and I had observed its beneficial results. Under chloroform the pulps of the four incisors were removed. The baby became a sound, healthy boy. He is now a member of the Stock Exchange, is about six feet in height, and has a fine set of teeth. They are of good quality and articulate in what might be termed normal occlusion.

When we carefully scrutinize cases such as these we are impressed by the absurdity of the doctrine that periclasia is the etiologic factor of some type of malnutrition, etc. If dentists were accustomed to visit sick patients at the bedside, and to study the pathology of the body as a whole, this practice of putting the "cart before the horse" would be forever abandoned.

When the pumping machinery of the heart is in any way deranged, the gum imprint is unmistakable. There is the congenital bad heart, where there is a constant lack of oxygen—and the cyanosed gum, and the palate with its deep purple color, spell heart disease. Acquired heart disease, especially after the age of thirty, presents even more impressive diagnostic indicators. This is especially true of tall people where the pumping power is not quite powerful enough, so that the oxygen in the capillaries is practically lost before the capillaries empty into the veins. In such cases you can frequently observe the lower

portion of the gingiva, for the distance of about a quarter of an inch, to be purple in color. This color ends abruptly, and above it remains the normal pink tissue. Such cases frequently develop a pyorrhetic condition, but the pink gum on one side and purple color on the other invariably indicates heart disease.

Fatty degeneration of the heart shows the gums in an anemic state. They gradually lose their attachment to the pericementum, with the formation of very deep pockets. The few cases under my observation were entirely free from any calcific deposit. Despite the greatest care these pockets became steadily deeper, even while under treatment. Two such patients returned from a cure at Marienbad, Austria, however, with a loss of weight of forty-odd pounds, and with the gums reattached to the pericementum and no pyorrheal pockets present.

Diabetes is a type of malnutrition that is essentially different, from a pathological viewpoint, from anything else. Between a mild glycosuria and a severe diabetes there are varying degrees of intensity. In no other disease does the gravity of the symptoms change so quickly and so often, and the pathologic appearance of the gums, especially at the gingiva, keeps pace with this transformation. The gums become spongelike, dark red, and bleed at the slightest provocation. When the disease is in a state of activity, instrumentation under the gingiva is not only painful, but the post-operative pain increases in severity, and if persisted in may result in the death of the patient. It is the intense pain and unsatisfactory reaction after surgical interference which is the marked diagnostic factor in diabetes.

Whether the pregnant mother's diet is furnishing sufficient nutriment to the developing foetus is of very great importance. I have found that, when this diet is insufficient, there is a diagnostic mark on the lingual surface of the gums in the posterior part of the lower jaw. This has been noticed in eleven different cases. The fact that it has never been seen under other circumstances, and that it disappeared immediately after diet had been corrected, is strong corroborative evidence that it is a diagnostic factor of no mean importance. The sign consists of an elliptical area of about one and a quarter inches mesio-distally, by about one-half inch in the other direction. This area has an inflamed appearance, with a dark red color in marked contrast to the color of the adjacent normal gum. There is a sharp

line of demarcation. The surface of this area, and of the rest of the gum, are in the same plane.

Nephritis in its various phases is one of the most tragic diseases. It is very seldom diagnosed in its early stages. The presence of albumen and casts in sufficient quantity in the urine is the generally accepted basis of its diagnosis. This inflammatory process of the kidney may be present for years before urinalysis shows any marked amount of albumen and casts, and yet from the very beginning its diagnostic sign can be read in the mucosa about the necks of the teeth. Some of the symptoms consist of loosening of the teeth; separation of the gingiva from the pericementum, and an intense pallor of the gum for at least a quarter of an inch over the neck of the tooth. Besides this, one marked physical sign is seen only in some types of nephritis. This is a marked hypertrophy of the gum, observed on the lingual side of the upper teeth, about an eighth of an inch above the edge. This hypertrophy is about the shape and dimension of the lead in an ordinary pencil. In shape it follows the convolutions of the necks of the teeth. This hypertrophied area is generally in segments, the cordlike appearance being broken at intervals by tissue of normal thickness. Judging from the observation of many cases, it is my belief that this hypertrophy is manifest soon after the onset of the disease.

While I could detail many diagnostic factors of other systemic conditions, we will for the present confine our attention to these signs. What is the significance? It is the written report of my observations during a period of over 45 years, corroborated only by co-workers at different periods. The expression of my observations has been recorded with the strongest feeling of regard for truth, and avoidance of any possible exaggeration of fact. If I have made any mistake, it has not been with any intent to deceive. If I am correct in my observations, it means that the dentist should so train his mind as to be able to differentiate between gingivitis (however filthy the mouth, however severe the inflammation) and periclasia, which is always symptomatic of some systemic trouble. The former trouble has a favorable prognosis and can always be cured by intelligent treatment. The worst criticism of present-day dentistry is that a large class of men insist on erroneously classifying as periclasia these exaggerated types of gingivitis.

On the other hand, periodontoclasia is curable only so far as the disease of which it is a symptom is curable. Most of the severer forms are never seen by the dentist, as the patients are either bedridden or inmates of a hospital. But whenever the original disease is cured, the mouth conditions are as amenable to treatment as the other type of local inflammatory cases.

The average physician at the present time, on account of his ignorance of everything concerning the dental tissues, is in no position either to criticize or to make proper use of these diagnostic factors. When the time comes that the medical student receives proper instruction in the principles of dentistry, the value of the mouth as an early diagnostic aid in disease will be recognized, and then medicine will have made another great advance.

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DISCUSSION

E. E. Smith, M.D., Ph.D. (*New York City*): The paper of the evening presents a point of view which so strikingly departs from our ideas in regard to the subject that there is an inclination at once to reject the views of the author as not only radical but unjustified, either by general experience or by any reasons that he has set forth to establish his conclusions. More mature consideration, however, and especially the memory of previous occasions when with time skepticism has given way to at least a measure of conviction (if not of the whole yet of a part sufficient to constitute a real advance in knowledge), teach us that the views presented tonight demand our serious, intelligent, and constructive criticism.

I take it that the author, in his presentation, is not considering the production of systemic disease from mouth pathology but rather the reverse, namely, the reflection of systemic disturbance in the establishment of conditions of the dental tissues.

As I see it, there are three possible positions regarding this relation of mouth pathology to systemic disease. *First*, that there is no interrelation whatsoever, any simultaneous occurrence being merely accidental, a matter of chance. *Second*, that the abnormalities of the mouth are only generally and not specifically related to systemic disease. That is to say, they result from a general lowering of resistance—a diminution of antibodies, to use the present-day expression of this idea—and particular mouth pathology is not

the necessary and invariable accompaniment of a particular systemic disturbance.

Third, that each form of systemic disease expresses itself, or at least is accompanied by a particular pathology of the mouth, so that the recognition of the latter becomes a diagnostic sign of the former.

It is to the possibility of this third position that the paper of the evening has given emphasis. No one, I think, will hold that there is an entire absence of interrelation between the dental tissues and systemic disease, so that we may dismiss the first position we have mentioned. The real question is between the second and third positions, namely, to what extent does systemic disease reflect itself in specific rather than general states of the dental tissues. I believe that the idea prevails in the minds of the majority of the medical and dental professions, so far as they have given the matter thought, that the relation is, in the great majority of instances, a general one. The speaker of the evening has presented the conviction that the relation is a specific one, at least to such an extent that in many instances, some of which he has cited, the state of the dental tissues furnishes a true diagnostic sign of the systemic disease.

Let us follow him in his thought in this matter. On the one hand we have certain dental pictures, and on the other the systemic condition which each dental picture reflects. (See the summary on the following page.)

The speaker of the evening has made a notable contribution in emphasizing, in this systematic way, the relations of these conditions of the dental tissues to particular systemic diseases. Those of you who are familiar with this subject by reason of clinical experience can add much to this presentation by verifying these observations or, if need be, by noting any differences in regard to them. I do not at all doubt, and regard it as entirely logical to believe, that important relations such as these do exist and have gone unnoticed to a regrettable degree.

If the author had limited his presentation to this aspect of the subject, so far as my knowledge permits, I could only commend him for his shrewd and valuable observations. But he has gone beyond this, and asked us to consider these facts in their bearing upon the hypothesis that every condition of systemic disease produces changes in the dental tissues even to the extent that such changes are diagnostic of the systemic disease. Stated differently, we are to believe that every systemic disease finds a pathognomonic sign in the dental tissues. The author does not say this in so many words, and I may be going further than he is willing to go in using this form of statement. Nevertheless, the author does seem to take the third, rather than the second position, previously described, namely, that each form of systemic disease

SUMMARY: COMPILED FROM DR. RHEIN'S PAPER

Stage	*Dental tissue*	*Systemic*
First	Healthy	Healthy
Second	More or less severe type of gingivitis, without periclasia; amenable to simple surgical intervention Etiology: Lack of proper mouth hygiene, with or without localized irritation	No apparent disease
Third	In addition, true periodontoclasia	Something wrong in the blood stream
Fourth	Bluish tinge of gums	Mercurial poisoning
Fifth	Mucous follicles in the gums secrete visible amounts of fluid	Pulmonary tuberculosis
Sixth	Mucous follicles frequently destroyed. Gum very attenuated in thickness	Old chronic cases of phthisis
Seventh	Acid reaction to blue-litmus paper placed under the lip	Acidosis
Eighth	Common canker sore	Interference with the normal action of the digestive tract
Ninth	Stomatitis	Poisoning from bacterial toxins in the digestive tract
Tenth	Pyorrhetic condition	Lack of vitamins in food
Eleventh	Extreme gingivitis with destruction of enamel	Scurvy
Twelfth	Cyanosed gum and palate. Purple color may end abruptly, with normal pink color above	Heart disease
Thirteenth	Anemic gum, losing its attachment to the pericementum	Fatty degeneration of the heart
Fourteenth	Gums sponge-like, dark red, bleed readily. Instrumentation under the gingiva painful, with post-operative increase in severity	Diabetes
Fifteenth	Elliptical inflamed and dark red surface of gum, with sharp line of demarcation	Insufficient diet of pregnant mother
Sixteenth	Loosening of teeth, separation of gingiva from the pericementum. Intense pallor of gum for at least a quarter of an inch over the neck of the tooth. In some types, marked hypertrophy of the gum on lingual aspect of the upper teeth, shape and dimensions of lead of pencil, and following the convolution of the necks of the teeth	Nephritis

expresses itself or at least is accompanied by a particular pathology of the mouth, so that the recognition of the latter becomes a diagnostic sign of the former.

Now, pathognomonic diagnostic signs are a rarity in medicine, quite as much or even more so than are specific treatments. Any such relation of the conditions in the dental tissues to systemic disease is contrary to the general rule. I don't suppose physicians have studied any disease manifestation more than, if as much as, fever; and of all the fevers, the one most taught to the medical student is typhoid fever. Yet it has been said of typhoid that, if the classical text-book descriptions of its clinical manifestations were reversed—that is to say, if it be described as not presenting diarrhoea, not presenting rose-spots, not presenting splenic enlargement, not presenting the characteristic headache and delirium, etc.—such description would in fact apply to as many (or even more) cases of typhoid as conform to the classical picture.

As a rule, the diagnosis cannot be made from any one clinical sign, though there may be one or even several signs that are highly suggestive of it. Disease is a complex; and it is so because individuals are individuals, and further, because they are complex individuals. The diagnosis of a particular disease is not made, as a rule, from a single sign, but only from a consideration and careful weighing of a considerable number of symptoms and signs. One individual reacts in one way, another may react in quite a different way, to the same inimical factor, be it infection, toxin, mechanical imperfection of the body, or other form of etiology. Were each individual body, exactly like every other body, the disease manifestations would always be the same. But because the bodies of individuals differ, so the reaction to disease etiology differs; as a rule, manifesting itself more or less differently in different individuals.

In consequence, the most that can be said of one sign or symptom is that it is a single sign or symptom to be weighed with other signs or symptoms in arriving at a diagnosis of the disease with which the individual is affected.

In applying these general principles to the matter at hand, let us consider the simple condition of pallor of the mucous tissues of the mouth, including the gum. It means a hemoglobin deficiency of the fluid circulating in the capillaries. This may arise from a poor blood circulation, such as the speaker associates with feeble cardiac action—fatty heart, if you wish. But equally as well it may occur from a poor quality of the blood due to a secondary anemia—chlorosis, or a pernicious anemia—for which reason it may be suggestive of fatty heart, although in no sense is it diagnostic

of that condition, and in the majority of cases is certainly not due to fatty heart.

Again, an acid reaction to litmus of the mucous surfaces shows merely a localized acid condition, not of necessity at all indicative of a systemic acidosis with an accompanying lowered carbon-dioxide combining-capacity of the blood, which is what the term "acidosis" signifies.

Pyorrhetic conditions are by no means limited to individuals lacking vitamines in their food, and so are not diagnostic of this food deficiency, even though that may be a cause of pyorrhetic conditions.

Some nephritics may have as a part of their disturbance the conditions of the dental tissues described, but it would require a special and elaborate investigation to establish that the gum condition described is a regular occurrence and may be relied upon to establish the diagnosis, although it is reasonable to believe that in some cases it may be a helpful sign.

In thus pointing out the limitations of gum conditions as diagnostic signs, I would not be misunderstood. I do not deny possible valuable relations that should be more generally recognized, as the paper has emphasized. Only I am fearful lest, in claiming too much, we fail to establish the valuable relations that do exist, and so accomplish less in furthering a recognition of these relations than the recognition of the existence and importance of the more conservative few would achieve.

What has been said should convince both physicians and dentists of the importance of careful study and interpretation of the dental tissues as indicative of systemic states and diseases, that a full knowledge of such states and diseases may be obtained. It is by attention to such helps that the professions will be enabled to serve better, and the interests of patients will be better served.

John Oppie McCall, D.D.S., F.A.C.D., F.A.A.P. (*New York City*): It is an honor to be asked to discuss this paper of Dr. Rhein's, and one I keenly appreciate. After hearing the masterly discussion just given by Dr. Smith, I feel that anything I might say would be superfluous. I may, however, be able to add something from the purely dental aspect of the subject.

After many years spent in close observation of the various abnormal conditions manifesting themselves in the gingivae, I have become impressed with the many variations to be seen in cases presenting essentially the same pathologic conditions. When we add to this the variations in the pathologic conditions themselves, which are to be found in cases of periodontal disease, it is difficult to state that any one abnormality is invariably pathognomonic

of a certain condition of the gingivae. In cases presenting themselves for treatment, we also find great variations in the physical condition of the patient, from apparently perfect health to a condition of advanced disease. It has been my observation that even where we should expect to find a parallelism between the state of the general health and the state of the periodontal health, such relationship is anything but fixed. I find patients with advanced periodontal disease, yet without signs of systemic complications under the examination of the most thorough internist. Conversely, I have seen patients whose health was seriously involved, whose periodontal tissues exhibited a high resistance even to such pronounced irritants as traumatic occlusion.

As applied to the subject of Dr. Rhein's paper, I take this to mean that similar variations between the occurrence of certain systemic diseases and the appearance of characteristic symptoms in the mouth are to be expected. If this is so, it naturally lessens the value of the signs which Dr. Rhein has described. And, in fact, he himself makes a statement which negatives the invariable character of these signs, viz., that scrupulous home care may postpone the appearance of these signs in the mouth.

I have for some time been familiar with Dr. Rhein's theory regarding these signs and have endeavored to make use of them in my practice. In some cases I have been able to observe the correspondence between some of these signs and the disease conditions which he mentions. In other cases, I have been unable to get a physician to confirm my suspicions as to the presence of certain systemic diseases. I have also seen cases of advanced disease in which the oral signs which Dr. Rhein mentions as being invariably present, were, in fact, absent.

I recognize the probability that through lack of proper instruction in these signs, and because many of them are difficult to describe, I have failed to recognize some of them when present, or have misinterpreted those I did observe. And I think it is safe to assume that others in our profession and even in the medical profession suffer from the same disadvantages. I do not know whether this has been done or not, but I am sure it would be very desirable to form a class or committee of dentists and physicians, which, with Dr. Rhein at its head, should visit a suitable hospital, and make clear these various signs and their significance. I for one would gladly enroll in such a group. In this way a satisfactory demonstration of Dr. Rhein's theory could be given.

I am glad that Dr. Rhein mentions the closing up of pockets. This is aside from the main thought of the paper, but I cannot refrain from mentioning it. It is a phenomenon which I have repeatedly seen and which I

have claimed could be brought about, despite insistence of many in the profession that such healing could not occur.

In closing, let me compliment Dr. Rhein on this most interesting paper. It has been a pleasure to read it and to discuss it. And if the things which he states do occur with the degree of regularity he claims, these signs assume a place of great importance in both medicine and dentistry.

A. G. Freedman, D.D.S. (*New York City*): This is a very valuable paper. I wish to compliment Dr. Rhein on his presentation of the subject, which is a great incentive to us to look into matters that have escaped our attention. We should study what we see in the mouth. Whether these signs can be utilized to reach a better diagnosis is a matter for the future to decide. This will depend on the value of the observation. For instance, the detection of Koplik's spots in the mouth is very important. A child may be brought to the dentist, apparently not sick, but the symptoms may be there already and should be recognized at once. Again, there is the strawberry tongue of scarlet fever. If this is observed, the patient must be told to go at once to the doctor. The physician will give credit to the dentist who has called attention to these facts.

Dr. Smith made very scientific and most practical comments, and nothing can be added to his discussion. He personified the older sister, medicine, speaking to the younger sister, dentistry, extending a friendly hand of welcome and a vision of hope for real service, but wisely defining what medicine would exact from dentistry before depending upon its aid. Dr. Rhein, however, is making history in dentistry this evening. With enthusiasm he presents a vision of the service to be brought in the near future through the field of dentistry.

I feel certain that Dr. Rhein has studied and checked up his cases. Neither the medical nor dental profession would depend upon one man's conclusions, no matter who he is. Whether these signs of definite pathological conditions observed in the mouth can be utilized for a better medical diagnosis is a matter for the future to show. Let us hope that it may be so.

Dr. McCall's suggestion, that a committee be formed to make observations at the bedside and on clinic patients, is practical and most valuable. When we can check up a sign in the mouth, and in a definite number of cases trace its connection with a specific pathological condition, then there will be a substantial contribution to symptomatology in medicine. Such a contribution to medicine by dentistry, as Dr. Rhein suggests, would be second only to the contribution of Dr. Morton, a dentist, in the development of general inhalation anesthesia as a routine surgical procedure. It would not

only make Dr. Rhein's name outstanding, but it would show the medical profession how close is the relation between systemic disease and oral abnormalities.

I. Hirschfeld, D.D.S. (New York City): For several years I have been pretty much of the same state of mind on the use of the mouth as a means of diagnosis. I was inspired to that by some remarks of Dr. Rhein. Even before, however, I noticed mouth conditions that were of systemic origin. I have been watching fairly closely, to the extent of going to the hospitals to look for this correlation. I am not sure that all that Dr. Rhein has said is exactly so. It would be wonderful to have Dr. Rhein's help, as Dr. McCall suggested. It would help the dentists, and it would also help humanity. Last week I was called to a hospital to diagnose a mouth condition. I looked for the follicles referred to by Dr. Rhein, but in two mouths I failed to find them. With the medical interne I went through the tuberculosis wards, and examined several mouths. Of the patients having pulmonary tuberculosis, there was one case of tubercular laryngitis. I tried to find follicles on the lips and gums. I do not say that they were not there, but I could not find them.

There are particular cases where one can state that the oral condition is of systemic origin. In one girl of 19, for instance, there was a history of osteomyelitis in various parts of the body. All of the teeth, except three molars, had periclasia. This was clearly of systemic origin. There are other conditions, such as pregnancy tumors, which are obviously part of the systemic condition.

A. S. Walker, D.D.S. (New York City): I feel that I am not qualified to discuss this subject, but I would like to mention one thing. I had the very good fortune to attend the meeting of the second District Dental Society, in January, 1911, and to hear G. V. Black, the great master, discuss the subject of pyorrhea. I recall faithfully the remarks he made. Let me quote his words: "I have never seen a case of pyorrhea where there was not malocclusion or faulty contact." I have observed many cases since then, and I have not seen any case of pyorrhea without malocclusion or faulty contact. This has been passing through my mind as I listened to the very able discussion of the subject.

A. B. Kinney, D.D.S. (New York City): Dr. McCall made a very valuable suggestion when he proposed the formation of a group for the study of oral signs of various diseases. I believe we should form a committee to make a

more extensive classification of symptoms and check up these findings. They do appear, but not in every case. I was in a class of Dr. Rhein's in 1910, and he taught us then to look for the "whip-cord" appearance in patients with heart lesions. In every heart case I have seen since that time I have looked for this sign, but I have not found it. That was in 1910, and I am still looking.

J. B. Schneer, D.D.S., Chairman (*New York City*): Recently I saw a man about fifty years of age, thick set, of solid appearance. His teeth, except for the lower four anteriors, were free from disease. The ordinary treatment for periclasia did not suffice. Dr. Hirschfeld looked at the teeth, and he thought the man should see a physician. Urinalysis disclosed 4 per cent of sugar. With treatment for the glycosuria, and without any other treatment, the teeth tightened up. This instance proves that systemic conditions have a definite effect in the mouth.

Max Kahn, M.D., Ph.D. (*New York City*): I have treated thirty diabetics in the hospital. In the gums there were many indications of a general pathologic state, but I was not able to arrive at definite conclusions on the relation between the condition of the gums and diabetes. There are many varieties of diabetes—perhaps more than of periclasia. On several occasions I noticed that, as the blood sugar approached normal, the inflammatory conditions cleared up. This indicates a general relationship.

Dr. Rhein (*in conclusion*): What I presented tonight was a preliminary communication. Only a small portion of the diseased conditions, to which I have paid such attention as to be able to recognize their mouth indicators, have been described. There are so many different types of disease, and so many more diseases themselves, that it has been utterly impossible for me to study the mouth indications of all of them. I have not been able to devote the time required for numerous visits to different institutions, to make a comparative study of different mouths and to distinguish the characteristic mark of each departure from the normal. It is almost a foregone conclusion that this can be done, and nothing would please me better than to go with a suitable committee (a small one, if possible), and, at the bedside of the patient, explain the various indicators in such a manner that they would be readily appreciated.

Dr. Smith's assumption is correct. After forty-eight years of careful observation, I am convinced that the mouth is a pathognomonic indicator of anything that can be spoken of as systemically wrong. Of course, devot-

ing myself as I have done exclusively to stomatology, there are many diseases which have not come under my observation during the past forty-five years. I am continually seeing symptoms in the mouth that indicate change from the normal; but my failure to study these particular indications makes it impossible for me, without special study, to understand just what they do indicate. Many such problems are still unsolved.

I am in thorough accord with Dr. Smith's statement regarding the differences that exist in different people. No one knows better than an observing dentist that no two mouths are absolutely alike. But when we realize that the tissues of the body are continually wearing out and need replenishing, and that nutrition comes only through the circulation, it follows, as a logical deduction, that whenever there is anything wrong nutritionally, it will produce its characteristic manifestation in some part of the body.

Dr. Kinney, speaking of the time she was in my class, said that she remembered my description of the "whip-cord" appearance above the gingiva in heart disease. This is a serious error of recollection on the part of Dr. Kinney. My article on "Oral expressions of malnutrition," published in 1896, describes this whipcord-like condition (of which I spoke this evening as being about the thickness of the lead in a pencil, and following the convolutions of the gingival surfaces of the upper teeth, etc.) as a positive indication of nephritis. If Dr. Kinney looked for this in patients with heart disease, she would look in vain, unless there was distinctive inflammation of the kidney, of which it is an absolute indicator, and has nothing at all to do with heart diseases.

Dr. McCall seems to think that the fact that ideal mouth prophylaxis reduces the vulnerability of the dental tissues (a condition on which we both agree) is an argument against the value of these diagnostic signs in the mouth. This argument does not appeal to me because, though this careful home prophylaxis may retard mouth diagnosis to some extent, as the disease progresses it is bound, soon or late, to produce its manifestation in the mouth.

There are notes in my files of many cases of nephritis where for years my dogmatic diagnosis was ridiculed by physician after physician, until the patient finally died of Bright's disease. I have in mind a German dentist who brought his wife to me for advice in regard to pyorrhea. The teeth were loose, and there was an anemic condition around the gingiva, with the characteristic hypertrophic whipcord appearance. I informed him that his wife had Bright's disease and that local treatment for the cure of the pyorrhea would be in vain; but that the proper thing for him to do was to

have the advice of a physician who was competent to regulate the hygiene of her life as well as of her diet. He took his wife to one internist after another, and my diagnosis was ridiculed by each in turn. Notwithstanding this, his belief in the correctness of my diagnosis was unshaken, and he took his wife to Germany where he remained for two years. For over a year and a half the diagnosis of the New York internists was confirmed by every specialist who examined her, although it was evident she was becoming more and more ill. One day, however, a professor in Heidelberg, after examining this woman for the first time, told him that if he wanted her to die in America he had better take her home at once as she had but a short time to live because of the severe type of Bright's disease that was present. Four months later the patient died. A case like this brings vividly to our view the lack of ability of medical science, with its present methods, to diagnose conditions of this kind in their early stages.

Dr. Hirschfeld seemed to imagine that I was speaking of tuberculosis in general. I referred simply to pulmonary tuberculosis. I have not seen those signs in any type of the disease but lung tuberculosis. He has made a slight mistake in speaking of my observing these excretions of the mucous follicles on the lips. I have simply referred to their activity in the gums. I do not know that I have ever seen any mucous follicles on the lips, at least not in any state of activity. Dr. Hirschfeld must have misunderstood my description of glandular activity for a description of a growth.

In regard to the indicator of impaired nutrition in pregnancy: I can only say that the number of cases of which I have a record is quite limited, because the condition that caused them forty years ago are not present at this time. The public has been educated in dietary matters. When I began practice there was a horrible fad, among women in New York, of trying to have an easy accouchement by avoiding foods that tended to produce osseous structure. So-called physicians of a certain class recommended deficient diets of this nature. I have a keen recollection of losing patients in my early practice because I refused to retain those patients who insisted on using any such diet. Such conditions, however, are a thing of the past.

In the classification of pyorrhea that I presented before the American Dental Association, in 1894, I divided the different types of pyorrhea according to the form of malnutrition or other systemic cause, and I have had no occasion to change my point of view in regard to this classification.

One of the most marked types of periodontoclasia that appears to me to be a positive circumstantial witness of the correctness of my deduction is that occurring as a result of fatty degeneration of the heart. In these cases,

while the gum loses its attachment to the pericementum for a great distance under the gingiva, there is no calcareous deposit on this exposed root surface. The pockets simply fill with soft forms of different kinds of detritus. It seems impossible that these pockets will ever be closed, or that such teeth can be saved. Yet in two cases that I recall, where no improvement was had from the most careful prophylactic measures, they returned from a cure at Marienbad, Austria, with the gum condition entirely healed, although they received no dental treatment during the cure. Cases of this kind vividly demonstrate the important rôle played by nutrition.

In this relation, the manner of speaking of "receding" gums demands especial attention. This term should not be used. The gums do not recede. They simply fail to receive sufficient nutriment, and there follows death of the surface. This is superficial necrosis, and not recession of the gums. I can best express the condition in reciting the clinical case of a young woman who was my patient from infancy, and who took the very best prophylactic care of her mouth. She was a very keen, ambitious student; entered Barnard College; and attempted work that taxed her recuperative powers beyond their ability. With all the preventive care possible, the cementum became exposed beyond the necks on all of her upper teeth. When she was married, fillings had been inserted on the labial and buccal surfaces of all these teeth, owing to the erosion that set in after the cementum was exposed. She left this country and went to live in a little village in Switzerland. When I saw her again, a few years later, she had two children, the elder five years old, and the mother was a typical hausfrau. She had received a thorough mental rest cure, and continued to observe carefully everything she had been taught about home prophylaxis of the dental tissues. When I examined her mouth, none of the buccal or labial fillings could be seen. The gum tissue had been restored and extended down normally to the necks of the teeth, completely covering the fillings that had been inserted before she was married. Tissue starvation undoubtedly occurred while she was a student; but, when her nutritive condition had become normal, the destroyed gum was regenerated.

MEDICO-DENTAL CASE RECORDS: THIRD REPORT[1]

A Clinico-pathological Study

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I. Case N-1 (1)[2]: Neuritis (2)

General history and physical examination

A male patient, forty-six years of age, was seen in consultation on December 9, 1925. The chief complaint was excruciating paroxysm of pain in the right arm, radiating to the right chest. The patient was employed as a clerk (3). The family history (4) was negative. When a child the patient received a multiple compound fracture of the left leg, resulting in complete ankylosis of the knee joint and compensatory partial equinus position (5) of the left foot. He had an abscess of the middle ear about ten years ago. Since then there has been a tendency to occasional heavy colds with bronchitis and a low grade fever, lasting for several weeks, once or twice a year. For the past three years this tendency apparently has been controlled by prophylactic vaccine inoculations. There was no history (6) of acute infectious disease, tonsillitis, or rheumatism.

[1] The previous reports were published in the *Journal of Dental Research—First:* vi (1926), pp. 283–303; *Second:* vii (1927), pp. 115–126.

[2] The numerals in parenthesis refer to the numbered items in the "Notes and comment," on pages 280–283.

The first symptoms of the present illness were noted in June 1925. The onset was gradual, and at this time slight twinges of pain were felt in the right forearm. There were slight transient attacks every few days during June and July. During August, when the patient was on a vacation, the attacks became progressively more severe each day. Pain was localized in the flexor surface of the right forearm; no radiation was noticed at this time. There was complete freedom from discomfort in the intervals between the spasms. Use of the affected arm apparently did not initiate attacks. The attacks continued during September, and at this time radiation into the right side of the chest was noticed, especially during any attempt to walk briskly. Attacks continued at intervals during October, but never extremely severe. During November there was an occasional attack of excruciating severity, when the pain in the right chest was of an acute, smothering character somewhat similar to angina pectoris.

Physical examination showed a well developed and nourished man; general condition, good; weight, 172 pounds. The pupils were regular, equal, and active to light and accommodation (7). The throat, ears, and sinuses were negative. The heart showed no enlargement; the sounds were of fairly good quality, no murmurs were elicited; the rate was regular but somewhat rapid (100–110 per minute). The breath sounds were somewhat emphysematous (8) in character. The abdomen was negative. General neurological examination was negative. Local neurological examination was negative except for a slightly diminished sensation over dorsum of right hand, the area of radial nerve; there was a slight weakening of the grip of the right hand. There was no limitation of motion, the reflexes were normal, there was no atrophy and no paralysis.

Report of the dental consultant

Oral examination. "Oral examination reveals a slight deposition of salivary calculus and a mild gingivitis. There is advanced dental caries. The oral hygiene is moderately good."

Roentgenographic examination. "Study of the roentgenograms reveals the presence of pathological conditions of the periodontal (9) and periapical (10) tissues. There is chronic suppurative pericementitis (11) with alveolar absorption in the region of the lower anterior teeth; also chronic rarefy-

ing osteitis (12), affecting the superior left first and second bicuspids, the superior right lateral incisor and second bicuspid, the inferior left second molar and second bicuspid root fragment, and the inferior right first bicuspid. The superior left cuspid and the inferior left first bicuspid are pulpless teeth showing chronic proliferative pericementitis" (13).

Comment. "The oral condition is probably an etiological factor in the patient's general condition."

Recommendations. "Advise the removal of all pulpless teeth in several stages to avoid, if possible, the severe exacerbation (14) that may result from rapid toxic absorption following the removal of many teeth at one time. Procain-suprarenin (2 per cent) is the anesthetic of choice. Cultures should be taken for study."

Laboratory and miscellaneous data

Urinalysis (15) (*December 7, 1925*). Color, clear amber; specific gravity, 1.020; albumin, absent; sugar, absent; indican, absent; microscopic examination, negative.

Blood examination (16) (*December 7, 1925*). Hemoglobin, 80 per cent; white blood cells, 10,400 per cmm; polymorphonuclear leukocytes, 50 per cent; large lymphocytes, 17 per cent; small lymphocytes, 31 per cent; transitional leukocytes, 4 per cent; eosinophilic leukocytes, 4 per cent.

Roentgenographic examination. "Roentgenographic examination of the chest reveals no evidence of cervical rib (17), and no abnormalities of the heart or aorta. The lungs show a moderate degree of emphysema and generalized increase of bronchial markings indicative of a low-grade bronchitis."

Tentative diagnosis. (a) Possible cervical rib, (b) possible tumor of the spinal cord, (c) infectious neuritis of dental origin.

Treatment and operations

Medical treatment. Complete rest of arm in sling; partial splinting to immobilize index and middle fingers; counter-irritants locally; prolonged heating by electric pad; heavy doses of salicylates and iodides; tolysin up to 40 grains daily for long period; luminal and pyramidon during attacks; morphine hypodermically or procain intramuscularly during the most severe paroxysms.

Oral surgical treatment. Seven teeth were removed in four operations. The usual 2 per cent solution of procain containing epinephrin was the anesthetic employed.

At the *first operation* (December 9, 1925) the superior left first and second bicuspids were removed and the sockets were lightly curretted. Four cubic centimeters of the anesthetic solution were employed. At the time of this operation the patient was suffering severe pain in the right arm. Within a few minutes after the injection of the procain solution there was an alleviation of the pain (18). There was an exacerbation of intense severity, several hours following the removal of these teeth, relieved by intramuscular injection of procain (19).

Second operation, December 10. The superior right lateral incisor and second bicuspid were removed at this operation. Four and one-half cubic centimeters of the procain solution were used. The pain from which the patient had been suffering was almost immediately relieved by the injection of the procain. The exacerbation following this operation was of severe intensity, again necessitating control by intramuscular injection of procain.

Third operation, December 21. The inferior right first bicuspid was removed at this operation. Two and one-half cubic centimeters of procain were used. Again, the pain which was severe before the injection of procain was relieved by it. There was no exacerbation resulting from the operation.

Fourth operation, December 28. The left first and second molars were removed at this time. The usual mandibular injection, employing 2.5 cc. of the solution, was administered. The patient had had no return of pain since the previous operation and there was no exacerbation following the removal of these teeth.

Bacteriological report. Cultures from the apices of the superior left first and second bicuspids showed a streptococcus viridans in both plates. Autogenous vaccine (20) was not prepared.

Follow-up record, February 1, 1927

There was a complete and permanent cessation of all pain following the third operation for the removal of the infected teeth. For several weeks after the infected teeth were removed there was an occasional slight discomfort of the right arm following excessive use. Since

February 1926, there has been complete freedom from symptoms of any kind. For the last year the patient has been in good general health, has attended to his business regularly, and was able to play golf as usual during the summer and fall of 1926, with no return of the symptoms of neuritis. Physical examination was essentially negative at the time of this follow-up record. Weight, 175 pounds. Blood pressure (21), systolic 130 mm., diastolic 80 mm.

Blood examination. Hemoglobin, 90 per cent; total number of white blood cells, 9,100 per cmm.; polymorphonuclear leukocytes, 60 per cent; large lymphocytes, 7 per cent; small lymphocytes, 30 per cent; transitional leukocytes, 2 per cent; eosinophilic leukocytes, 1 per cent.

II. General Summary

The history and physical examination of this case indicate that all factors, either etiological or contributory, were found to be negative except the dental foci. Oral examination showed a multiplicity of dental infections, and it was the logical procedure to detoxicate the patient by eliminating this infection, whether or not it was the sole etiological factor, and thus raise the resistance of the patient. While the blood examination showed an increase in the total number of white cells, the differential count showed a relative decrease in the polymorphonuclear leukocytes, coexistent with a lymphocytosis, which tends to indicate a lowered resistance from some focus of infection.

The acute exacerbations following the removal of the infected teeth were anticipated, but the sudden complete, and permanent relief of symptoms following the third operation was a most interesting reaction. This tends to indicate that in some cases, even though all foci of infection may not be eliminated, there is sufficient detoxication to abate the acute symptoms of a disease, at least temporarily. Although the superior left cuspid and the inferior left first bicuspid were pulpless teeth that showed chronic proliferative pericementitis and were indicated for removal, they were not removed at this time.

The improvement in the patient's general condition, the complete relief of all symptoms referable to the neuritis, and the improvement in the condition of the blood as shown by the differential cell count following the removal of the teeth, indicate that the dental foci were the probable etiological factor in this case.

III. Conclusions

1. Toxemia from oral sepsis may be an etiological factor in producing severe neuritis.

2. The sudden, complete, and permanent relief of all symptoms, as recorded in this case, tend to indicate that, when neuritis is infectious in origin, the irritation is due to the direct action of toxins upon the nerves rather than to the circulation and localization of bacteria.

3. Examination for oral foci of infection should be an early consideration in the treatment of neuritis. If either periodontal or periapical infection is discovered, it should be eliminated as a potential if not an active factor in the etiology of the disease.

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IV. Notes and Comment

Explanatory and supplementary

It seems desirable to include, in this section, elementary terminology of both medicine and dentistry, for the medical notes may be of value to some of the dental profession, and the dental notes may be of interest to some of the medical profession.

(1) Case N-1. As these cases are reported, they will be classified according to diseases of the various organs and systems. Thus, the symbol N, represents the group of neurological diseases.

(2) Neuritis. Neuritis is an affection of the peripheral nerves, of an inflammatory or degenerative nature, characterized by sensory, motor, and trophic disturbances in the areas of distribution. The process may be acute or chronic, and it may be confined to a single nerve or group of nerves (localized neuritis), or may involve many nerves at one time (multiple neuritis).

Localized neuritis may be traumatic in origin and result from contusion, compression, or actual severing of a nerve. Compression is a common cause of neuritis, which may be due to immoderate use of the muscles, prolonged maintenance of an awkward position, the presence of a supernumerary cervical rib, or from pressure of an enlarged lymph-node, aneurysm, or tumor. Neuritis may be caused by direct extension of an inflammatory process from contiguous tissues, as occurs in neuritis of the facial nerve due to caries in the temporal bone. Exposure to cold of superficially situated nerves may bring on an attack of neuritis, and exogenous poisons such as

lead, arsenic, mercury, carbon monoxide, and alcohol are etiological factors. Multiple neuritis may result from general infections such as diphtheria, typhoid fever, syphilis, tuberculosis, influenza, rheumatism, and septicemia. Probably no infection can be omitted from the list, which should include focal infections. Undoubtedly general infections and intoxications make the nerves more prone to degenerative changes, upon slight injury or even moderate compression. Many cases that have been described as having no known cause (idiopathic) probably belong to the toxic group resulting from some primary focus of infection.

In neuritis, owing to the extension of inflammation, the nerve is usually swollen, infiltrated, and red in color. In multiple neuritis the nerve-fibers themselves are mainly involved in a process of degeneration and atrophy. As a rule the constitutional disturbances are slight. The most important symptom is *pain* of a boring or stabbing character, usually felt in the course of the nerve and in the parts to which it is distributed. The nerve itself is sensitive to pressure, and the function of the muscle to which the nerve-fibers are distributed is impaired and motion is painful. The pain in neuritis is variable—sometimes intense and distressing, and at other times causing but little inconvenience (Osler).

(3) Occupation. Because certain occupations bring employees into close contact with exogenous poisons, which are capable of causing neuritis, it is important to consider the occupational environment in the history of a case of neuritis. Prolonged maintenance of an unusual position may be a predisposing occupational cause (2). Dentists may thus develop neuritis.

(4) Family history. Important because of its relation to predisposition to disease.

(5) Equinus position. A permanent fixation of the foot in deformity, in which the heel is drawn up in such a manner that the patient walks upon the ball of the foot or the toes.

(6) Past medical history. Enquiry into the past medical history is made for the purpose of ascertaining the previous diseases of the patient that may have a bearing upon the present illness. This is particularly important because of the relation of the infectious diseases to multiple neuritis.

(7) Pupillary reactions. (a) Reaction to light: The normal pupil when exposed suddenly to light stimuli responds by a reflex contraction of the iris. A sluggish reaction to light or total abolition of the light reflex signifies optic atrophy, partial or complete paralysis of the third cranial nerve, or degenerative changes in the ciliary ganglion. (b) Reaction to accommodation: When the range of vision is suddenly transferred from a distant objective point to an object near at hand, the pupils will be observed to contract

and the eyes to converge. This is the reaction to accommodation. Abolition of this reflex is due to paralysis of the third cranial nerve.

(8) Emphysema (pulmonary). The presence of air in the pulmonary tissues consequent upon rupture of the air cells.

(9) Periodontal. Relating to the supporting tissues surrounding a tooth.

(10) Periapical. Relating to the region surrounding the apex of the root of a tooth.

(11) Chronic suppurative pericementitis (periodontoclasia). A disease process that produces a breaking-down of the tissue supporting the teeth.

(12) Chronic rarefying osteitis (granulomatous). This is the condition resulting from the thickening of the peridental membrane that takes place at the expense of the bone of the alveolar process. As proliferation of the round cells occurs, the bone becomes rarefied and finally destroyed, leaving the space filled with chronic inflammatory tissue, the granuloma (Blair and Ivy).

(13) Chronic proliferative pericementitis. This is the first change in an infected apical peridental membrane. This condition is characterized by a thickening of the tissue. The invading organism is usually of low virulence of the non-hemolytic type. The inflammatory reaction is chronic, slowly progressive and proliferative in nature, giving rise to little apparent disturbance.

(14) Exacerbation. An increase in the severity of a disease or its symptoms.

(15) Urinalysis. This is the process of analyzing and obtaining data for the composition of a specimen of urine. This specimen is normal.

(16) Blood examination. Blood normally contains the following cellular elements: Red cells, 5,000,000 per cmm.; white cells, 7,500 per cmm.; the leukocytes are differentiated mainly into: (1) Polymorphonuclear neutrophilic leukocytes, 60–70 per cent; (2) lymphocytes, 25–33 per cent; endotheliocytes, eosinophilic leukocytes, and basophilic leukocytes are found in small numbers in normal blood. All inflammatory and suppurative processes cause a degree of leukocytosis dependent upon (a) the severity of the infection, and (b) the resistance of the individual.

(17) Cervical rib. The presence of a supernumerary cervical rib may cause neuritis by compression on a nerve or group of nerves.

(18) Relief from pain following injection of procain. The observation that pain from neuritis was almost immediately relieved following the injection of procain for dental anesthesia was noted at the first and second operations. This phenomenon had been observed in previous cases, and

lead to the suggestion that procain be administered intramuscularly to relieve the severe paroxysms of pain.

(19) Intramuscular administration of procain. Two cubic centimeters of a 2 per cent solution of procain containing epinephrin 1:20,000 was injected intramuscularly for the relief of the severe pains of neuritis. This proved to be a very efficacious remedy—equal to morphine.

(20) Autogenous vaccine. A vaccine made from a culture of bacteria obtained from the patient.

(21) Blood pressure. Blood pressure is the force exerted by the blood upon the arterial walls. This pressure is measured in millimeters of mercury. Systolic pressure is the pressure of the blood during ventricular contraction. Diastolic pressure is the pressure of the blood during ventricular relaxation.

SUSCEPTIBILITY AND IMMUNITY TO SYSTEMIC DISEASE FROM FOCAL INFECTION[1]

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I. INTRODUCTION

Susceptibility and immunity are each variable conditions. The term susceptibility implies this, but as immunity suggests a fixed condition, the term insusceptibility is employed by many writers as the more appropriate word. Immunity, however, is the more compact and commonly used term, and is generally understood by the profession and public to be the antithesis of susceptibility. The majority of mankind is inherently immune, or develops immunity, to the serious acutely infectious diseases, else man would long since have disappeared from the earth; but it is the sub-acute and chronic infections, insidious and slow of establishment, to which he is susceptible and which cause disability at a premature age, or terminate his life before the average of adult expectancy.

[1] Read at a meeting of the New York Academy of Dentistry, Hotel Commodore, New York City, on January 27, 1927.

II. NATURAL IMMUNITY

Immunity may be natural (inherent) or acquired (spontaneous), active or passive. Natural immunity is that which is inherent in an individual; as evidenced by those who without vaccination, serum treatment or any special prophylactic measures, escape infection and illness during epidemics, although they are as thoroughly exposed as those who develop the epidemic disease. This is probably due to active phagocytic action destroying the microörganisms and to certain antitoxic elements in the body fluids that neutralize the bacterial toxins and perhaps also inhibit bacterial growth. A natural immunity, however, may be of the type in which active phagocytosis does not occur and the bacteria grow and flourish, but disease does not develop because the body fluids contain antibodies that agglutinize the bacteria and prevent dissemination of their toxins. This type is demonstrated by individuals known as *carriers*. The typhoid carriers, who are distinctive in this group, show no clinical symptoms of the disease, and yet are incubators and distributors of the infection. The contents of their intestines contain active typhoid bacilli as can be proved by laboratory examination. Some of the human race are comparatively immune to one infection but hypersusceptible to another; as for instance, negroes are quite immune to yellow-fever but hypersusceptible to tuberculosis.

III. ACQUIRED IMMUNITY

Acquired immunity may be spontaneous (autogenous), active or passive. Spontaneous immunity is that which is acquired by the autogenous or automatic development of antitoxin in the body fluids during the progress of and recovery from some infectious disease, in the treatment of which no therapeutic serum has been used. In some instances these spontaneous antitoxins persist for years after recovery, conferring practically permanent immunity, as in recoveries from small-pox, scarlet fever, measles, and yellow-fever. In some diseases, however, the period of spontaneous immunity after recovery is very brief and reacts into a long period of increased susceptibility, as in certain types of pneumonia and influenza. Active immunity is the type developed slowly by vaccines or repeated in-

jections of small doses of dilute toxins and is of fairly long duration. Passive immunity is the type developed speedily by therapeutic doses of antitoxin in aborting an infectious disease, and is not as prolonged as an active or spontaneous immunity. These last types are also termed *artificial immunity*. But no type of immunity can be regarded as an absolute immutable condition through the average span of life of any individual. A general immunity may be destroyed by faulty diet, both as to quality, quantity and combination of the food and drink; by unhealthy environment, and by unhygienic habits of life; and by trauma.

The establishment of disease of infectious etiology depends upon the following factors: the virulence of the infectious agents, the resistance of the host, and the point of attack. While an individual may be relatively immune in general, there may be certain vulnerable regions due to trauma, disfunction, or predisposition, and these possibilities make the point of attack a matter of consequence. Struempell and others attempted to reduce the problem to a mathematical equation: "D" representing Disease, "C" representing Cause, and "R" representing the Resistance of the host. Their equation was: $D = \frac{C}{R}$. But, since some of the susceptible factors may be in the process of development without resistance having been dangerously diminished, a variable intermediate state called predisposition may arise in an individual as concerns one organ or group of organs, or an inherited predisposition may exist involving an organ or several associated organs. Senn, therefore, modified the equation so that to use the same terms, Disease equals Cause multiplied by Predisposition, divided by Resistance: $D = \frac{C \times P}{R}$.

IV. ENTRY PORTS OF INFECTION

The entry ports of infections (not including those due to trauma) are the digestive tract, the urinary tract, the respiratory tract, and especially the regions of the nasal tract and its accessory sinuses, the tonsils, and the teeth. The tonsils and the teeth are particularly important as portals of entry—the tonsils, because they are rudimentary organs and therefore are locally susceptible to infection, like

that other rudimentary organ the appendix, the removal of which has no influence on metabolic processes. The teeth are likewise exceedingly important, with their multitudinous cavities of infectious caries which may penetrate into the pulp and so launch infection into the blood stream, and the pericemental infections destroying alveolar, cortical and cancellous bone, and thus eroding capillary walls until infection is sucked into the venous circulation. While we must freely admit the possibility of a primary focus of infection in the intestinal region, the prostate, gall bladder, appendix, spleen, the sphenoidal, ethmoidal, frontal, and maxillary sinuses, nevertheless, with the exception of the venereal diseases and tuberculosis, the two most frequent portals of infections that lead to metastatic infections are the tonsils and the teeth. Since teeth are in our special field of observation and service, I shall devote the greater part of the remainder of this paper to that source of systemic disease.

The etiology of disease is a complex problem. The study of this problem is so complicated by a mass of clinical phenomena, some clear and some obscure, which must be considered in conjunction with a variety of laboratory findings, some corroborative, some contradictory and some negative, as to lead to widely differing deductions. Many times logical deductions are as important as keen clinical observations and careful laboratory technique. With such a variety of evidence, due to the fact that while the human organism is moderately uniform and constant in many matters it fluctuates amazingly in biochemical reactions, much literature has accumulated and the opinions expressed differ so definitely that the problem still remains a matter of intense discussion and investigation.

V. CLINICAL EVIDENCE OF FOCAL INFECTION

Benjamin Rush (1), physician of the period of the American Revolution, stated that he had observed, as had other physicians of his time, a connection between the extraction of decayed and diseased teeth, and the cure of general disease. In later years, W. D. Miller traced a coincidence between systemic disease and infections of the teeth and jaws. Then, Hunter of England published a broadside against the current practices of our specialty of that time, citing numerous clinical cases of disease, the study of which convinced him

that they were caused by dental infection, and were cured or greatly benefited by the elimination of such infection. The matter was placed on a scientific basis between 1905–1914 by Billings (2) in his published reports of clinical observations by himself, Irons, Brown and Nadler, supplemented by the laboratory findings and experiments of Hektoen, Rosenow and LeCount. More recently, the researches of Rosenow and Meisser (3), and Nickel (4), aided by the clinicians at the Mayo Clinic, have more definitely established the etiologic relation. These latter researches have been corroborated by Gay, Haden, and Price.

Many men of the medical and dental professions became so radical that they condemned to extraction every pulpless tooth, regardless of the degree or character of infection; indeed, regardless of the fact that in many instances infection could not be demonstrated by any regional diagnostic means. Finally, two queries began persistently to intrude themselves: first, "why do many individuals with apparently infected pulpless or pyorrheic teeth show no evidence of systemic involvement?"; second, "why has the extraction of pulpless teeth sometimes failed to benefit the patient?" To the first question the following logical answers may be given: The individual may have developed an active immunity, from repeated absorption, into the circulation, of small immunizing quantities of mild toxin; the infection may have been walled off either by a fibrous cyst, or an area of impervious sclerotic bone (these cases of complete isolations, however, are exceedingly rare); or the pulpless teeth were not infected. The following answers may be applied to the second question: The pulpless teeth were not infected; there was some other source of a more virulent infection that was undiscovered by the medical diagnostician, and the oral infection was accessory rather than principal; permanent anatomic tissue changes had occurred at the metastatic localization before the teeth had been extracted; a simple extraction had failed to eliminate all the focal infection adjacent to the extracted teeth; and there was another undiscovered dental infection.

VI. SKIN TESTS OF IMMUNITY AND SUSCEPTIBILITY

Until recent years, there has been no way of definitely determining who was susceptible or immune to various infectious diseases, except

as demonstrated during epidemics, when obviously certain individuals escaped infection although they were exposed as fully as those who fell victims to it. Lately, research workers developed what are known as *skin tests* of susceptibility to various bacterial and protein toxins. Now we have skin tests for the various food poisons, for the pollen toxins, for diphtheria, and for scarlet fever, all of which have been proved and accepted by the medical profession. These results led a member of the dental profession, Kauffer of New York, to endeavor to develop a test that would disclose whether infected teeth were a systemic menace, or whether they could be safely retained in the mouth. He attempted to demonstrate, by means of a skin test, the immunity or susceptibility of individuals to the infections in and about their teeth, and has published in *Dental Cosmos* (5) the results of years of experimentation and observations. I wish to express my appreciation of his labors, and my belief in his sincerity of purpose, even though I am not convinced of the logic of his deductions. The profession, and still more the public, are debtors to every earnest research worker who endeavors to discover new facts upon which more certain diagnosis can be made and from which successful curative measures may be developed.

Kauffer's skin test for susceptibility to systemic involvement from dental infection, is, he says, in many respects similar to the Dick skin-test for scarlet fever. The Dick test, however, is for an acute disease of brief prodronal period, with marked febrile symptoms and skin inflammation that is so severe as to result in desquamation. The same is true (except as to skin involvement) of diphtheria, for which the Schick skin-test is employed, and also of the pollen skin-tests for vasomotor disturbances and of the food-protein tests for food idiosyncrasies. All of these afflictions have a mucous or dermal surface-reaction. It has been observed that only in a very small percentage of cases does dental infection cause skin disease. It is not skin involvement that causes so much concern, as it is the more frequent involvement of organs such as the heart, eyes, stomach, duodenum, kidneys; and the distressing, protracted, and many times disabling, attacks of myocarditis, endocarditis, neuritis, myositis, and arthritis, with their frequent disabling and deforming degenerative or proliferative end-results. The tissues of these structures may be

invaded and colonized by bacteria and react to toxins that do not invade or affect the skin. The classical experiments of Rosenow, Meisser, Nickel, Gay, and Haden, prove this conclusively.

Kauffer reports that in 400 cases of skin tests, with cultural toxins from infected teeth, the percentage of susceptible individuals as determined by him was less than 20 per cent, but unfortunately he does not report the percentage of the various types of dental infection from which cultures were made and the test solutions derived. I think it is important to know what percentage of these dental infections were of the type that had evident pus, without any root filling; what percentage of them had a partial root filling, with devitalized pulp material beyond, which though infected had not liquefied into pus; what percentage were from cases that showed periapical bone destruction, without erosion of the apical pericementum; what percentage did show denuded root-ends, with periapical destruction; what percentage had some known systemic involvement as well as dental infection. It is also important to know if the blood and urine were normal, in the cases that gave negative reaction to the skin test. Furthermore, unfortunately, he does not detail the method of culturing and the preparation of the test solution. Apparently there is no filtration, since he speaks of the "saline suspension containing five thousand millions of the dead organisms with their proteins to a cubic centimeter," so that apparently it is not a pure-toxin skin-test. Nor does he state another important point as to whether all the test doses were injected at the same period of time after they were obtained from the cultures. It is furthermore to be noted, that but one culture is used for each test made. He does realize one of the weak links in the chain of the technique of the test which he frankly confesses, and that is, that the culture organisms having been grown on an artificial medium, there may be a difference in the virulency of the culture organisms from those developed within the individual. And also that there may be other protein toxins, formed by the breaking down of tissue cells that are not included with toxins from organisms grown outside the body. Consequently, since his percentage is so much lower than that noted from clinical experience, and since his test solutions contain such large numbers of the dead bacteria, I believe his positive reactions to be anaphylactic reac-

tions, and that his skin test is an allergistic test rather than an immunity or susceptibility demonstration.

The Drs. Dick (6) found in their experiments, covering a number of years, that there were but two strains of streptococci hemolyticus with which experimental scarlet fever could be developed. They first found a specific strain that fermented with mannite and they thought this a specific strain-identification test. Subsequently they isolated another strain that did not have a fermentation reaction with mannite, but also produced typical experimental scarlet fever, and so today the only method of recognizing the scarlet fever strains of this species of streptococcus is by the ability to develop from their toxins experimental scarlet fever in human volunteers, as none of the lower animals are susceptible to this disease. Other investigators, in attempting to prove the Dick test, found that in many series their percentages of positive reactions were less than one-half of the 41 per cent average of susceptible adults reported by Drs. Dick. Then the Dicks, in their further experiments, found that it was necessary to have on hand test doses of standardized scarlet-fever toxin, against which the new productions of toxins that were being made could be tested for standards of strength. They found some of the culture toxins required twice the dose that they had determined with the standardized toxins was a safe standard dose for the skin test, while other cultured toxins were of such virulence that one-half the standard test-dose produced the same skin reactions that the standard toxin did. So it has come to be their practice to discard immediately any lot of toxins that does not produce, in a known susceptible subject, the same skin-test reaction as does the standard test-dose of the standardized toxin. Therefore, it is evident at once that the matter of using a single culture, with the same average test-dosage, presents an additional possible factor of error in results. These detailed facts, and the criticisms of the Kauffer skin-test, impel me to decline to accept Dr. Kauffer's estimate as a dependable percentage, or his test as a definite demonstration of systemic immunity or susceptibility to dental focal infection. It must also be remembered that, to obtain a specimen for culturing, access must be obtained to the area of infection. If this is attempted by removing the root-canal filling, the fact must not be overlooked that root fillings cannot com-

pletely or safely be removed by instrumentation alone, and that all the solvents for root-filling materials have an antiseptic action and therefore will exercise a modifying influence both upon the bacteria immediately beyond the root fillings and their toxins. Furthermore, many of these areas of infection are inaccessible by any safe method of opening from the exterior without extraction, as for instance, the apical area of the palatal roots of the upper bicuspids that are double rooted, and the periapical area of the palatal roots of the upper molars. In most cases the same criticisms apply to external opening into the periapical areas of the lower second bicuspids and the lower molars.

We cannot logically disregard radiographic findings, and laboratory tests of blood and urine, and decide upon a method of treatment of apical infected areas, based upon a skin reaction alone, with any assurance that the infected teeth may be safely retained. Every experienced and well informed dental and medical practitioner has been convinced, by clinical results, that blood examinations, urine analyses, and radiographic findings are of utmost importance in determining the probable successful elimination of dental infection following treatment, and the degree of safety with which infected teeth may be retained. It is true that periapical infection is usually a local infection, and it is also true that it usually results in a metastatic distribution of that infection to other regions of the body, even though it may take a number of years before the metastatic infection is clinically evident to the patient. Kauffer's enthusiasm for the certainty of his skin test has led him into error of expression when he states that, "for every patient the physicians can show me with a gastric ulcer and tooth infection we can show him 10,000 patients with tooth infection and no gastric ulcer," because the occurrence of gastric ulcer is at least 15 to every 10,000 of population. He has made another error when he states that, "if we remove all pulpless teeth merely in the hope of eliminating possible foci we will sacrifice 9,999 teeth to cure one gastric ulcer," because the subject matter under discussion is not pulpless teeth, many of which are not infected, but teeth which are infected. And even though he might be able to present 9,999 cases out of 10,000 with infected teeth and no evidence of gastric ulcer, yet out of 10,000 cases which have pulp or

periapical infection, he cannot in view of our clinical experience present even 40 per cent having no evidence of metastatic involvement elsewhere in the system. I should also like to point out that, in Kauffer's experiments and tests, it is of importance, as proof of the value of the test, to have a clinical case-record of the patient covering a period of years subsequent to the supposed immunity reaction from this skin test.

VII. USUAL TYPES OF DENTAL INFECTION

The predominant species of microörganisms found in pulp-canal and periapical infections, as well as in the marked pyorrheal pockets, is streptococcus. It is known that these organisms are highly mutable, and sensitive to various culture media and to oxygen tension. In fact they are so sensitive to these factors that Rosenow has, as is well known, succeeded in transmuting a pure streptococcus into a pure pneumococcus; and has also been able to reverse this transmutation from pneumococcus into streptococcus. In the intermediate stages of mutation they may show a marked increase of virulency. As has been pointed out, infections from certain strains of pneumococcus leave a patient after recovery with a long period of increased susceptibility, and the same may be suspected and has frequently been demonstrated to be the case with a majority of streptococcal infections. Such an infection may remain dormant in a focal area for a period of years and the host seem immune, when, because of some change in the biochemical reactions of the individual, it suddenly becomes more virulent, more invasive, and spreads through the system in such a manner that often the patient is prostrated with a general septicemia and sometimes fatally overwhelmed by it. In view of this known characteristic of streptococci infections it cannot be safely assumed that, because a patient in April is evidently immune to their toxins and resistant to their further invasions, as far as general physical and clinical conditions are observed, he will not be susceptible in October of the same year. We are all familiar with the clinical manifestation of a dormant infection suddenly becoming active, not only with great local disturbance but also with marked general symptoms; the urine becomes altered, fever

develops, and there is an increase in heart action, which becomes irregular. These symptoms indicate the establishment of a general septicemia; a marked general reaction, without evidence of a new infection having invaded the individual. This reaction may indicate a loss of immunity. I have called attention to the fact that repeated doses of small amounts of a weak toxin may convey an active immunity covering a long period of years, but if for some reason the amount of the toxin forced into the general circulation is increased either in quantity or virulency, the patient will in the course of a comparatively short time show, by clinical evidence of either metastatic localization or general toxic symptoms, that immunity has been lost and that susceptibility now exists.

VIII. LOADS AND OVERLOADS OF INFECTION

Dr. Kauffer, during his clinic at the Seventh International Dental Congress in Philadelphia, made the statement to me that he "did not regard the blood examinations, the urine analyses, or the blood pressure readings, of any consequence in determining whether or not an infected tooth was a menace to the individual, because the pathological findings might be due to another infection somewhere else in the system that had not been disclosed. This being the case, and if the dental infection was eradicated by surgical means, the patient's condition would be harmed rather than benefited by the procedure, because as only an overload of infection was removed, the ensuing improved clinical condition resulted from the elimination of but a portion of the infection, thus permitting any other undisclosed infection to become a more serious menace before it makes itself manifest." I must confess that I fail to see the logic of Dr. Kauffer's deduction, for I think it is beyond all reasonable controversy that, as you reduce the load and especially the overload of infection in an individual, the bodily forces are given a better opportunity to resist acute infection and to combat other foci of infection. If the other foci become manifest there will be less danger of an acute general pathological reaction and the patient's chances of recovery will be greater, if all known infections have been located and eradicated. To my mind it is essential to eliminate every focus of infection that

may be found in the body. They can never be regarded as bestowing any benefit upon the individual, but must always be regarded as a menace to his general health and efficiency; and perhaps may become a menace to his life; or, worse, cause permanent confining disability which cannot be relieved.

Blood and urine analyses, temperature and blood-pressure readings, cardiac examinations as well as radiographic findings, are far more definite proof of systemic susceptibility or immunity of an individual to focal infections than any skin test which has yet been devised. The skin is seldom involved in cases of focal infection, as will be demonstrated further on in this paper.

IX. FACTOR OF ERROR IN RADIOGRAPHIC FINDINGS

Radiographic examinations are too frequently depended upon as conclusive in diagnosis of oral pathological conditions. Clinical experience has demonstrated that an error of 20 per cent may occur; that is, 20 per cent of the cases examined, although declared radiographically normal, were nevertheless discovered upon operation to have areas of definite infection. This is due to the fact that a type of infection existed that did not produce local tissue destruction; or that nature, in an effort to wall off this infection, had developed a sclerotic area in the cortical layer of bone of sufficiently increased density to mask the area of rarefication or destruction in the cancellous portion of the bone. Conversely, it has also been discovered that about 10 per cent of the cases radiographically diagnosed as regions of infection, upon operation and culturing of the curetted contents, prove to be sterile and are regions in which tissue changes have apparently occurred as a result of instrumental trauma or the excessive use of powerful medicaments. In the effort to reduce this percentage of error it is the practice in all the large well developed clinics to have present at the operation the radiologist who has submitted an opinion, that he may see the actual condition of the tissues as disclosed at that time and observe whether they corroborate the apparent condition as diagnosed by him from the radiograph. Even a cursory study of the regional anatomy of the roots of extracted teeth discloses the fact that many roots have an abrupt deviation in the line of the direction

of the rays, and that infection of these periapical areas, with limited destruction of bone and the formation of small granulomas, may exist without the slightest evidence of it in the radiograph.

The same criticism applies to the policy of excluding the sinuses, as a possible etiologic factor in disease, by radiographic interpretation and transillumination tests alone. A positive infection may exist in them with an accumulation of thin but virulent pus without sufficient thickening of the membrane or bone structure to produce the usual appearance of infection. Conversely, there may be a marked appearance of infection in the sinuses, which may be due to thickening of the membrane from the irritations of a previous but now non-existent infection; and upon opening these sinuses, they are found to be without infection. So it has come to be the practice of the more thorough nose and throat specialists to make a more definite diagnosis by local anesthesia, and the use of suction, to determine whether infection exists in the nasal sinuses. To revert to the dental aspect, there may have been death and infection of the pulp, and the root canal may contain virulent pus, without evidence of it in the radiograph. Many of us have had experience with teeth that, from radiographic findings alone, were passed as normal, and in which apparently the pulp was vital and without infection, but yet with thermal and electric tests and transillumination gave evidence of lost vitality—and upon opening into such teeth, the pulp-canal contents were highly infected and, after extraction, the periapical areas were very much involved.

It cannot be gainsaid that the pulpless tooth, however carefully the roots have been filled, is nevertheless a potential menace to the individual. The region of the apex of that tooth is prone to acquire a secondary infection from an acute infection elsewhere in the body. There is an area of lowered resistance at that point which offers a favorable colonizing place for bacteria. A primary infection may be an acute regional or general infection that, in a short time, reaches a climax and is promptly cleared up by natural processes. The secondary infection in the apical area of the pulpless tooth, however, caused by that acute infection in another region, persists and develops; and, in the course of time, becomes an independent focus of

infection from which there will be a slow metastatic distribution—localizing disease in other regions of the body and establishing a chronic type of non-specific disease, serious both as to suffering and to disability.

X. BLOOD AND URINE EXAMINATIONS

Blood counts (the specimens for which should be taken just before breakfast or luncheon to avoid the modifying influence of active food assimilation) that reveal a persistent leukocytosis or, more seriously significant, a persistent leukopenia, together with a disturbance of the normal differential percentages of the leukocytes, according to Daland (7), are symptomatic of the susceptibility of an individual to metastatic involvement from focal infection. If the erythrocyte count is below four million, and the hemoglobin percentage is below seventy, it must also be regarded as an indication of susceptibility to secondary infection from any focus of infection. A blood-sugar test should also be made. This should be done early in the morning before the patient has partaken of breakfast, other than one cup of clear coffee without sugar. If the blood-sugar content is found to be above the normal range (95 to 120 mgms. per hundred cc.) that person must be regarded as susceptible to any and every variety of infection. Pemberton, Cajori and Crouter (8) state that such a patient is at the threshold of diabetes. If the percentage of blood sugar is well above normal, the patient is a diabetic in the first stages of the disease, even though the sugar cannot be found in the urine, and he now becomes specially susceptible to either primary or secondary infection.

If the urine analysis shows a noticeable trace of albumin, or casts, and especially if sugar be found, that patient must be regarded as susceptible. If the blood-pressure reading discloses a high systolic pressure with an abnormal variation of the difference between the diastolic and systolic pressure or, if there be a comparatively normal systolic pressure and a diastolic pressure that is but a few points below that of the systolic pressure, it must also be regarded as symptomatic in conjunction with the finding of focal infection. An elevated temperature or a fluctuating (rising and falling) tempera-

ture throughout the day, as well as abnormally fast and irregular heart-beat are also significant of systemic involvement.

XI. FREQUENCY OF RELATION OF SYSTEMIC DISEASE TO FOCAL INFECTION

The report of A. C. Nickel (4) of the Mayo Clinic, on the relation between systemic disease and focal infection, as well as the selective localization of bacteria spread by metastasis from focal infection, is most illuminating. In 332 routine cases from the infirmary of the Clinic, the number of various ailments were as follows: Arthritis, 138 cases; myocarditis and endocarditis, 11 cases; myositis, 12 cases; lesions of the eye, 38 cases; lesions of the skin, 8 cases; ulcer of the stomach and duodenum, 61 cases; and vague pains of distress without definite localization, 64 cases. In the 138 arthritic cases there were 149 foci of infection in the tonsils and teeth and prostate. (It will be noticed that some of these cases had two foci of infection.) In the 11 cases of myocarditis and endocarditis, 13 foci of infection were found; in the 12 cases of myositis there were 12 foci of infection; in the 38 lesions of the eye there were 38 foci of infection; in the 8 cases of lesions of the skin but 5 foci of infection were found; in the 61 cases of ulcer of the stomach and duodenum there were 77 foci of infection; and in the 64 cases without definite involvement but with vague pains of distress, 79 foci of infection were found. All of these foci were in the tonsils, teeth, prostate, or cervix. I would like to call your attention to the remarkably low percentage of lesions of the skin (only 8 cases out of 332), and also the low percentage of focal infection in these skin cases as compared to all the other cases.

In the injection experiments on animals, for the cases of arthritis, 60 per cent of the animals developed lesions of the joints from injections of cultures derived from the teeth. For the cases of myocarditis and endocarditis, 50 per cent of the animals developed lesions of the heart from cultures of infections of the teeth. For the cases of myositis, 38 per cent of the animals developed myositis. For the cases of lesions of the eye, 41 per cent developed similar lesions. For the cases of lesions of the skin, only 8 per cent developed skin lesions. For the cases of ulcer of the stomach and duodenum, 44 per cent developed gastric lesions. The percentage

of animals developing apparently vague distress, without definite involvement of any of the group of organs was of course difficult to estimate, but as far as could be determined there were 36 per cent. No differentiation could be made as to the percentage from the teeth, tonsils, or prostate. Throughout these tests for 332 persons, it was noted that the percentage of definite involvement in the experimental animal of the organs or regions similar to those affected in the patient was highest in each instance in those animals that were injected with the cultures derived from the infections of the teeth. The percentages of reproduction of infection from the tonsils and prostate very closely tally with one another, and were about one-half of the percentages obtained from tooth infection, except in the cases of lesions of the skin, where apparently the chief sources of infection were in the tonsils and prostate.

In another series of cases studied at the Mayo Clinic, 155 patients were examined to determine the relation that existed between systemic disease and focal infection and the incidence of secondary lesions was tabulated as follows: Arthritis, 82 cases; myocarditis and endocarditis, 9 cases; myositis, 10 cases; lesions of the eye, 11 cases; lesions of the skin, 4 cases; ulcers of the stomach and duodenum, 38 cases. All these cases had demonstrated foci of infection in the teeth, tonsils; prostate, or cervix. Again it will be noted that but 4 out of the 155 cases showed skin involvement. The percentage of animals that showed specific localization of the various diseases was 66.8 per cent. In other words, it was clearly demonstrated that two-thirds of the diseases from which these 155 patients were suffering were caused by metastatic spread from focal infection, and again I must ask you to remember that but four of these cases were involvements of the skin. This seems logical proof that the chronic development of metastatic infection from focal infection is about forty times more likely to occur in the tissues of the joints, heart, muscles, eyes, stomach and duodenum and kidneys, than of the skin. I think it is also perfectly logical to conclude that the failure to develop a skin reaction, from a culture derived from a focus of infection, does not signify that the other tissues of the body, representing far more important structures, are immune to involvement from that focal infection.

The amazingly high percentage of complete cures, or at least definite improvement in chronic systemic diseases, following the surgical removal of infections about the teeth and tonsils, is an added proof that focal infection may be a cause of chronic systemic disease. To my mind it is not a question as to whether general immunity or susceptibility can be demonstrated concerning any focal infection. Any and every infection of a chronic focal character is either an active or latent menace to the individual harboring it. After all, it is a question whether this infection can be eliminated by treatment, and with it the prospect that there will be no reestablishment of the infection. If the anatomy of an infected tooth, as revealed by instrumentation and the radiograph, discloses a possibility of complete removal of the pulp-canal contents to the apex; if in cases of periapical involvement, an external opening can be made so that thorough drainage and irrigation of the tract can be accomplished; or if the conditions of the case are favorable for apicoectomy, providing that procedure is necessary—I should not decline to treat, fill, and retain the tooth in the mouth, providing the general laboratory findings did not contraindicate it, regardless, despite any results of a skin test.

XII. CONCLUSION

Unfortunately, teeth that develop the greatest percentage of focal infection are the type in which the anatomy of the roots is apt to be abnormal, and they are so situated in the bony tissue that radiographic films seldom give a clear exposition of this abnormal anatomy. They are also so situated as to make the operation of apicoectomy a difficult, uncertain, and usually an unsuccessful procedure. It must be remembered, too, that infection about the apices of the teeth differs from infection in other parts of the body, because seldom does periapical infection ever succeed in establishing fistulae for surface drainage. It is this type of enclosed infection, with leakage into the surrounding tissues, that apparently develops the most insidious and dangerous type of infection in metastatic involvement. No one who has ever been in close contact with a case of neuroretinitis, with its pitiful march toward blindness and has observed it clear up following the surgical removal of infected teeth when all

other remedial measures had failed—or who has been in close touch with a case of ulcerative endocarditis, with its protracted agony until a merciful fatality occurs—will ever dismiss lightly the dangers inherent upon the retention of infected teeth. *Any of the essential teeth in the mouth can be replaced by modern methods of restoration, so that as to appearance and function they are a complete replacement. But retinas, optic nerves, heart valves, kidneys, and joints of the body cannot be replaced; and in the majority of cases, once they have become seriously involved, permanent tissue changes occur and they cannot be restored to even a minimal adequate function.*

Whenever we discover focal infection in our field of health service, the patient should always be most earnestly advised to have a thorough general examination by a competent painstaking physician; and his findings, in conjunction with those of our examinations, should determine our action in the case. The patient is usually willing to do this, if we earnestly state to him the facts. Patients should be informed that focal infections predispose to serious acute infections by lowering resistance, and, in the presence of focal infection, acute infection will be more severe and chances of recovery will be materially lessened; that focal infection causes secondary infections in other organs of the body essential to health and life, and that focal infections may be completely eliminated before they permanently damage the structure of those organs. Clinical experience and laboratory research have demonstrated that the majority of adults are naturally immune or acquire a natural immunity to the acute infections, *but are susceptible to metastatic infections from chronic focal infections.*

In closing, the writer wishes to express his appreciation of conferences with Drs. Rosenow and Nickel, of the Mayo Clinic; Dr. A. R. Elliot, of St. Luke's Hospital, Chicago; Drs. Lincoln and Gardner, of the Lincoln-Gardner Laboratory, Chicago; and especially, Dr. George F. Dick of Chicago.

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XIV. DISCUSSION

Judson Daland, M.D. (Philadelphia, Pa.): Dr. Nyman has concisely and truthfully described the present status of immunity and susceptibility to dental focal infection. I heartily agree with the theories, opinions, and conclusions advanced, and on the unreliability of Dr. Kauffer's skin test for susceptibility of patients with chronic periapical infection. You may recall that, when Dr. Nyman paid his gracious tribute to the pioneers

of focal infection, he mentioned a Philadelphian named Rush, an Englishman by the name of Hunter, a German by the name of Miller, an American by the name of Billings, and another American by the name of Rosenow. The profession of medicine owes a debt of gratitude to these research workers, more especially to Doctors Billings and Rosenow. Our present concepts of focal infection are essentially due to American research workers, and in this field, the United States is far in advance of any other country.

Immunity and susceptibility are two of the most abstruse and important subjects in medicine, and our knowledge, although only partially complete, is rapidly increasing. Bacteria long preceded man in the history of the world and are more primitive and more difficult to destroy; they are markedly influenced by environment, and eventually win in the warfare between life and death. The Chinese have become immunized and adapted to their environment by living many centuries under conditions impossible for the average European. The present generation of Chinese are the survivors of untold millions that have died because they were unable to immunize and adapt themselves to such an environment. The natural immunity of the Negro to yellow fever may have been transmitted from ancestors that had this disease, or may be due to an unrecognized attack of yellow fever in childhood. It is generally believed that the Negro, especially the mulatto, is susceptible to pulmonary tuberculosis. The full-blooded African is probably not hypersusceptible to tuberculosis so long as he lives in his natural environment, which is the tropics; but when he moves to the temperate zone, two or more generations are required to secure adaptation. The large and capacious nasal chambers permit the passage of large volumes of warm air in the tropics, but are unsuited for the cold air of the temperate zone. On the other hand, their teeth are remarkable for their strength, development, and freedom from disease, even though a tooth brush has never been used. Their upper and lower maxillary bones and their muscles of mastication are unusually well developed in striking contrast to the jaws, muscles, and teeth of the highly civilized individual of today. The character of the food, chiefly uncooked, required much mastication by primitive man, whereas modern food prepared by modern cooking, requires little mastication. Lack of use may be one of the reasons for lack of development of the teeth of modern man.

Immunity may be slowly destroyed by insufficiency of food; inability to digest food; insufficiency of oxygen, sunlight, or exercise; chronic diseases, such as diabetes or intestinal toxemia; certain occupations, such as that of a coal miner, or of workers in poisonous chemicals; or by the extension of

periapical infection, and absorption of bacteria and toxins. There may be a sudden but transitory loss of immunity from starvation; severe and continuous over-mental or physical exertion; prolonged exposure to wet or cold, without adequate clothing; loss of sleep; or an alcoholic debauch. The occurrence of pneumonia after severe injury, such as an automobile accident, may be due to a sudden loss of immunity. Local immunity may be decreased by injuries to nerves or by trauma. Phagocytosis is important in natural immunity, but immunity may exist in the absence of phagocytosis due to antibodies in the blood, lymphatics, fluids, and fixed tissue-cells. When any intercurrent disease such as influenza or typhoid fever occurs in a patient who has a streptococcic focal infection, immunity may be not only lost but the severity of the disease may be increased, complications are common, and the prognosis is less favorable. The simultaneous presence of two types of bacteria in an individual, as for example, the influenza bacillus and the streptococcus, may increase the pathogenicity of each. Symbiosis was probably one of the reasons for the frequency of pneumonia and the high mortality observed in the epidemic of influenza in 1919. If a patient develops mild secondary manifestations of chronic dental infection and spends three or four months on a ranch in the mountains of the West, living an active, healthful, outdoor life, free from care and responsibilities, and then returns home restored to good health, these hygienic measures have increased immunity, but the dental focus of infection still remains, and sooner or later secondary disease will appear.

According to Kolmer, toxins are probably chemically unstable. Colloidal toxalbumins of the nature of enzymes are thermolabile and digestible, and some possess the property of specificity, as for example, the streptococcus hemolyticus to the erythrocytes, and the tetanus bacillus to the nervous system. He considers the toxins of the staphylococcus and streptococcus as true, soluble toxins, capable of causing disease in man, with the usual symptoms of toxemia, i.e. fever, malaise, prostration, and hemorrhage. The streptococcic endotoxin is more specific, but less toxic than the soluble toxin; it repels leukocytes, diminishes or prevents phagocytosis, but has no influence over the lymphocytes. The various strains of streptococcus possess marked individuality and selectivity, which may be modified by environmental changes such as variations in oxygen tension, etc. In addition to the well known characteristics of streptococcus hemolyticus and streptococcus viridans in foci of infection, special strains of streptococcus are the cause of erysipelas, scarlet fever, measles, and mumps.

The systemic manifestations of chronic dental infection are due to the absorption into the blood of bacteria or toxins, or both. Ordinarily, the toxins are absorbed more or less continuously, and bacteria, intermittently. When ulcerative endocarditis, secondary to chronic periapical infection, occurs, it is evident that streptococci have entered the blood, and the streptococci in the ulcerated endocardium are the same as those in dental infection—and this same streptococcus may be recovered from the blood by culture. This disease is usually fatal. Most of the systemic manifestations of chronic periapical dental infection are due to toxins, which act as chemical irritants, as is illustrated by a patient who had pain and disability in the left sacro-iliac joint for one year, which disappeared within twenty-four hours after the extraction of one infected tooth. The bacteria usually found in chronic dental and tonsillar infection, causing systemic disease, are the streptococcus hemolyticus or the streptococcus viridans, each of which may possess pathogenicity and selectivity. Knowledge gained from a study of chronic dental infection is in a general way applicable to tonsillar infection and vice versa, because the bacteria are usually the same and their environment is often quite similar. Infected teeth may secondarily infect the tonsils and infected tonsils may secondarily infect pulpless teeth. Occasionally a tooth that has been treated and filled may become infected, not by dental caries or by the dentist, but by the tonsils or by an exogenous infection by the way of the blood or lymphatics. A pulpless tooth that has been treated and filled is always a menace, and may become an *unsuspected focus* of infection when an endogenous or exogenous infection occurs. When a primary focus of infection has been removed, a secondary focus of infection may become primary and cause systemic disease. The pathogenicity and selectivity of the streptococcus in the tonsils may be markedly changed after being transferred elsewhere, as for example, to the joints, where there is a more abundant supply of oxygen, so that eventually immunity to the tonsillar streptococcus and toxins is not adapted to the streptococcus that has secondarily invaded the joint. Multiple foci of infection are very common; the occurrence of dental and tonsillar infection is frequent; and occasionally a combination of dental, tonsillar, and sinus or prostatic infection occurs in the same patient. When multiple foci of infection occur in different parts of the body, the infective organisms may happen to be the same, but the strains may be different. If the predominating bacteria in the teeth and tonsils are the streptococcus, the bacteria in the sinuses may be staphylococcus. It is evident that when different toxins enter the blood, different antibodies must be made in order to immunize the individual.

The recognition of the typhoid carrier is important, but the streptococcus carrier is more frequent and more important. Examination of the throats of soldiers during the war revealed many streptococcic carriers and they speedily infected all the men in the barracks. Streptococcic milk, cream, cheese, and ice cream have frequently caused epidemics of streptococcic sore throat.

My experience with the amputation of the root of an infected bicuspid in one patient was exceedingly unsatisfactory. This patient had acute cholecystitis, secondary to an infected, upper, right, bicuspid tooth. The dentist decided to save the tooth by amputating the infected root apex, and then sterilized and filled the remaining root and crown. Several months later, an acute facial paralysis occurred, which promptly disappeared after the bicuspid was extracted. Cultures from the bicuspid, supposed to be sterile, showed the presence of streptococcus viridans. When the root of an infected tooth is amputated, it must be difficult or impossible to be certain that all infection has been removed, and it is more than probable, in most cases, that concealed and unsuspected dental foci of infection remain, which frequently causes secondary disease.

The staphylococcus albus or aureus is usually present in pyorrhea, and, when recovered from deep pyorrheal pockets, may be capable of producing serious disease, of which furunculosis is the most common. Pyorrhea in the region of the second and third molars may cause an infection of the tonsils, which may be chronic from the beginning, producing no signs or symptoms of tonsillar disease until systemic manifestations of tonsillar infection occurs.

The following case illustrates the temporary benefit secured by removing dental infection and overlooking another focus. Female, aged seventy, pale, emaciated and feeble; an examination of the blood showed anemia, leukopenia, and lymphocytosis. She was so ill that death was expected. The infected teeth were all removed, at several operations, and when cultured showed streptococcus hemolyticus. The patient slowly recovered and the blood became normal. The original symptoms and abnormal blood condition returned in ten months, and the removal of undiagnosed, small, submerged, infected tonsils was followed by complete recovery.

I am glad that Dr. Nyman has called attention to the frequency of infected teeth that are radiographically negative. The radiogram is most valuable for a single rooted tooth, but less valuable for multi-rooted teeth. Sometimes the roots of the molars, as shown in the film, are superimposed in such a manner as to render invisible a small area of translucency. In

other cases, an infected root of a molar may not show in the film because of the large amount of lime in the ramus of the jaw, which blots out the area of translucency. An area of infection may exist under the crown and between the roots, which cannot be shown by the x-ray. Imperfections in the film, or errors in development or placement of the film in the mouth, are contributory factors in producing negative x-ray evidence when infected teeth are present. Occasionally a vital tooth contains an infected pulp. Many pulpless teeth, showing no x-ray nor other evidence of infection, are often infected. The proof of the infection would be the recovery of the streptococcus hemolyticus or viridans from the periapical region, which is impossible without extraction.

From a rather extensive experience in the bacteriological study of extracted pulpless teeth, I find that such teeth are usually infected. Whenever arthritis, myocarditis, cholecystitis, or any disease secondary to chronic dental infection occurs, or a lymphocytosis with a corresponding diminution of polynuclear cells, with leukopenia and anemia exists, and no focus of infection can be discovered elsewhere, it is wise to remove pulpless teeth. When the extraction of pulpless teeth is not followed by a cure, it usually means that a focus of infection still remains undiscovered. This focus is usually a pulpless tooth that is erroneously believed to be non-infective, an infected root remaining after extraction, an undiagnosed infected tonsil, an infected remnant of tonsil after tonsillectomy, or an undiagnosed focus of infection in the sinuses or elsewhere. An important truth mentioned by Dr. Nyman is that every pulpless tooth is a menace. The absence of symptoms is often due to a high grade of immunity, which may be slowly or suddenly lost, and later it may be difficult to determine that the secondary disease is caused by the infected tooth. References have been made to the varying percentages of myocarditis, endocarditis, pericarditis, and ocular diseases, secondary to dental infection. Although the most common diseases secondary to dental infection are arthritis, myocarditis, endocarditis and pericarditis, cholecystitis, and neuritis, it must not be forgotten that *no* system of the body is exempt, and an enumeration of the diseases would resemble the table of contents of a text book of medicine.

The teeth are the most common location for a focus of infection and this is especially true in the latter half of life. The tonsils, as a focus of infection, are almost equal in importance especially in the young. The greater number of the teeth and roots make it difficult to diagnose and remove *all* foci of infection. The importance of dentistry has increased about fifty per cent since it has been recognized that dental focal infection

is the most frequent cause of many systemic diseases. The time has now arrived when dentistry should be a specialty in medicine, on a parity with ophthalmology, otology, and dermatology. The dentist should realize that he is responsible for the health as well as for the teeth of patients. If a patient has chronic pyorrhea or periapical infection, he should be referred to his family physician to determine whether secondary disease is present, as does the ophthalmologist when he discovers a retinal hemorrhage.

Herman J. Kauffer, D.D.S. (*New York City*): The subject of the evening, susceptibility and immunity, deals with one of the most complex problems that has confronted the medical profession in its entire history. Therefore it is not surprising that it should find our young profession in a state of confusion.

In reviewing Dr. Nyman's paper, I find he has made at least two fundamental errors in his criticism of the value of the skin test to determine the susceptibility of the patient with an infected tooth. *First*, he assumes that I would remove foci of infection in one class of patients and allow them to remain in another. In this he is fundamentally in error. I strongly and unqualifiedly advocate the removal of all foci of infection in all cases in which foci are known or even suspected to occur. What I have attempted to do is to demonstrate that different procedures may be adopted in two different classes of patients; those exhibiting an immunity to the infection and those exhibiting an absence of immunity. In the former the focus of infection may be eliminated by proper root-canal therapy, the infection cured, and the tooth retained. In the latter it is hopeless and hazardous to attempt to cure the infection by any treatment other than extraction. Dr. Nyman's *second* error is his failure to recognize that a skin test is not a test of the tolerance of the skin or a specific lesion of the skin, but is a test to determine tolerance of the body as a whole to the infection. Just as in diphtheria, the Schick test determines not skin susceptibility, but the susceptibility of the individual as a whole, so the skin test that I have advocated is similarly a test of the reaction of the individual to certain microörganisms.

If Dr. Nyman's contentions are correct, that is, that the skin is not a safe tissue for my test because, as he infers, it would react only to toxins capable of producing skin lesions, then to be consistent he must exclude the Dick and Schick tests for the reasons that not all scarlet fever patients display a fever rash, and very few diphtheria patients have skin manifestations of that disease. Therefore such patients, if Dr. Nyman's conten-

tions are correct, would not react to the Dick or Schick tests, even though they are susceptible to the disease. For if the disease itself would not cause a skin reaction, Dr. Nyman would not expect the toxin to do so. The reaction of tuberculine upon the skin is further proof of error in Dr. Nyman's contentions. Some individuals who show a negative reaction to the Dick test for scarlet fever will develop abscesses in the nasal sinuses whenever they come in contact with a scarlet fever patient; and the scarlet fever organism, the streptococcus of scarlet fever, can be recovered from these infected sinuses, although the patient shows no other symptoms of the disease. This patient can infect with scarlet fever another person, who will show all of the manifestations of a true scarlet fever. Now these patients are scarlet-fever carriers and still they are negative to the Dick

Fig. 1. Method of inoculation: introduce just the tip of needle, with bevel out, so that needle may be seen in the skin. A touch of the plunger is sufficient to produce a small white bud on the skin.

test. Had Dr. Nyman attacked my test from this point of view, it would probably have been more difficult for me to answer him. However, all other skin-reaction tests must stand the same criticism. In all of these tests the skin is, as Dr. Schick puts it, "a barometer determining the degree of presence or absence of antibodies."

Gernez and Razemon of Paris, France, report:

"Sixty subjects, who had not been vaccinated against enterococcus, were studied as to the reaction between fixation and intradermal reaction with respect to this organism. It was found that in those cases giving a positive fixation-test, the skin test was negative. That is, when antibodies are shown to be present, the skin test is negative. This is as might be expected, but it shows the application of a known principle in another type of infection. The inflammatory reaction which follows injection of the enterococcus into the skin is due to toxin, and results if the organism is not immune to this microörganism."

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 2. Negative reaction. *C* indicates site of control. *V* indicates slight redness at site of vaccine inoculation. This slight redness occurring at the time of the injection, or shortly thereafter, and disappearing within first six hours, is considered to be a protein reaction. Only reactions that occur after first six hours are of diagnostic significance.

Fig. 3. Positive reaction, twenty hours after inoculation. In this case both streptococcus viridans and staphylococcus albus were recovered. *C* indicates site of control; no reaction. *V* indicates *positive* skin-reaction to streptococcus viridans. *A* indicates *negative* skin-reaction to staphylococcus albus. It is interesting to note that when the two vaccines were combined and introduced into the skin, a strongly *positive* reaction occurred. A skin reaction of this character indicates that the patient is not taking care of the tooth infection, and the infected tooth should be removed.

Fig. 4. Strongly positive reaction, thirty-six hours after inoculation. *C* indicates site of control. *V* indicates *positive* skin-reaction. The infected tooth should not be saved when the skin reaction to that infection is as severe as represented in this illustration.

Fig. 5. Positive reaction, twenty hours after inoculation. *C* indicates site of control. *V* indicates *positive* skin reaction to the vaccine. *T* indicates *positive* skin reaction to contents of granuloma, after it had been rendered sterile by heat. *A* indicates mildly *positive* skin-reaction to saline suspension of granuloma.

At the Mayo Clinic, the presence of only eight cases of skin lesions in the series of 332 cases, and of four cases in the series of 155 patients, only demonstrates that few skin patients present themselves at that Clinic. Had the observation been made at the skin department of the Vanderbilt Clinic in this city, the numbers would have been just the reverse. That there were only five foci in the eight cases of skin lesion has no significance even were all five foci in one patient, because Dr. Nyman fails to state just what the skin diseases were—they may have been parasitical. That skin lesions did not follow in animal experimentation may be accounted for by the fact that the experimental animals were fur-bearing and that most

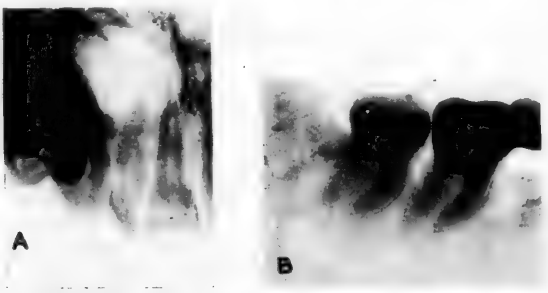

Fig. 6—A. *Left superior lateral incisor.* This tooth was negative to both thermal and electrical tests for vitality. The skin test also was negative. The granuloma was removed surgically, the root canal filled, and the tooth restored with a jacket crown. The patient is in good health today. B. *Left inferior second molar.* The periapical region is nearly radiographically negative. The mesial root-canal was opened, and a streptococcus viridans culture obtained. The skin-reaction was positive, reaching its height about the twenty-second hour. The patient had been suffering from brachial neuralgia, and it was decided to remove the tooth. Forty-eight hours after the tooth was removed the neuralgia disappeared.

of us are not. Dr. Nyman is right when he states "the skin is seldom involved in cases of focal infection." However, many skin lesions are considered just as likely to be the result of focal infection as are any of the other diseases of which Dr. Nyman has spoken, among them urticaria, eczema, erythema multiforme, *alopecia areata*, *lupus erythematosus*. Many other skin diseases are described by some authorities as being associated with focal infection, although this has never been positively demonstrated. However, let me cite one case. Dr. George M. McKee found a case of pemphigus at the Vanderbilt Clinic and discovered in that patient a bicuspid tooth that was infected. He sent this patient to me, asking immediate

extraction of that tooth, stating that the patient's dentist had refused to extract it. The tooth was removed. Some time afterward, when I saw Dr. McKee, he reported that the patient made a prompt recovery. It was very fortunate that he found the infected tooth, because this type of pemphigus frequently results in sudden and early mortality. Now of course his patient was dangerously ill. We would not think of making a skin-reaction test in a case like this. I fail to see why a low percentage of skin involvements in focal infection should lead Dr. Nyman to deny the value of a skin-reaction test for the presence or absence of antibodies. The two conditions are in no way related, and Dr. Nyman will have great difficulty in proving otherwise.

Dr. Nyman condemns my test because it lacks the elaborate preparation of the Dick or Schick test. He fails to comprehend the distinction that, for the Dick or Schick test, stock preparation is used, which must react uniformly upon all individuals having an equal degree of susceptibility or immunity, whereas with my test we take a definite organism from an infected area and introduce it into the skin of the same individual to determine the presence or absence of skin reactions. In other words, one is a stock preparation and the other an autogenous preparation. Let me say here, in regard to dosage in these tests, that frequently, when we introduce the vaccine (let us call it that), we wish to place it in the outer layers of the skin. When the needle is introduced too deeply, I take it out and make the test at another site in the skin. I have frequently found that by just penetrating the skin with the needle, moist with the vaccine, almost as much reaction is caused as when a certain amount of the vaccine is introduced. When I spoke of this to Dr. Tuwart, who has done a great deal of this work, he said that he too had observed the same condition, so that I do not think it is necessary to have an exact percentage for this test, although some percentage must be spoken of.

Dr. Nyman is right in calling attention to my failure to give case history, type of infection, etc., in the four hundred cases cited in my paper of 1926. We have most of the data and are trying to compile it.

As for cultures and preparation of solutions: the best method of securing a culture from the periapical tissue must be determined by the character of the case and therefore should be left to the operator. We usually obtain cultures through root canals. If the operator cannot prepare the root canal for culture purposes, he certainly cannot prepare it for complete root-canal filling, and such teeth would probably better be extracted. I fail to understand why Dr. Nyman should obtrude the question of using antiseptics as the usual method of enlarging root canals. Surely he would

not accuse me of attempting to get a culture over an antisepticized field. What we usually do, after the root canal has been prepared, is to dismiss the patient for several days with a saline dressing sealed in the root canal. At the next sitting a Johnson and Johnson paper point is placed in the canal, which is then flooded with normal saline solution, and sealed with gutta percha for at least forty-eight hours. The paper point is then carefully removed and dropped into a glucose-bouillon culture medium, after which it is sent to the laboratory for incubation, identification, and vaccine preparation. I believe that the best media to use, and the best method of procedure, may be selected by the pathological laboratory. I do not employ the stab method of passing a brooch through the root canal for obtaining cultures. The solution prepared from the culture is an ordinary autogenous vaccine suspension of five thousand million of the dead organisms to the cubic centimeter. We have found that with this concentration we get the best results.

I should like to tell you of a test that we have made with these vaccines. Five patients, all of whom had been tested more than three years before, were again inoculated with their original vaccines, so that these vaccines were more than three years old. Our records show that three of these patients had no skin reaction, and two had a positive skin reaction, when first tested. In the group of the three patients who had no skin reaction in the first instance, each received three inoculations, one of autogenous vaccine and one each of vaccines of the other two patients. Of the three autogenous vaccines, two produced no skin reaction, and one a mildly positive skin reaction. Of the six foreign vaccines (two in each patient), four gave positive skin reactions, and two gave mild responses. In the second group the autogenous vaccine again produced a positive skin-reaction. Two conclusions may be drawn from this test: these vaccines contain substances capable of producing inflammatory reactions; and some individuals are capable of resisting these inflammatory reactions, the resistance lasting possibly for more than three years.

As to loss of immunity, to which Dr. Nyman refers: he should remember that my test is made at a time when we are going to advise treatment as to which method to employ, i.e. extraction or root-canal therapy. In this diagnostic work most of my patients are now referred to me by physicians. We are finding a higher percentage of positive reactions in these sick patients than that in my earlier reports, where the information was gathered from patients who came to my office, or from cases from a skin clinic, with skin conditions that would not be caused by a focus of infection—we were dealing with patients having no known systemic disease. As for sensitivity

of organisms and the degree of transmutation: I believe that theory has not been accepted, and that Dr. Rosenow has himself abandoned it.

What I said to Dr. Nyman at my clinic before the International Congress at Philadelphia was that, taking a hypothetical case, infected teeth that had no definite relation to a patient's poor health were frequently extracted and the patient's health apparently improved for a time; but two or three months later the patient would relapse into poor health and a gastric ulcer would be found. The apparent improvement in the patient's health after the extraction of the teeth was, in my opinion, probably psychic or due to the removal of an overload and was not a benefit to him but quite the contrary. For, had the teeth not been removed at that time by a guess-rule of elimination, the case would have remained under observation, the gastric ulcer would have been recognized earlier, and the patient could have received medical treatment instead of having to submit to a surgical operation at a later date. The skin-reaction test is the only known method that enables one to avoid this error. Dr. Nyman says in his paper that, "blood examination, urinalysis, temperature, blood-pressure readings, cardiac examination, as well as radiographic findings, are far more definite proof of systemic susceptibility or immunity of an individual to focal infection than any skin test which has been devised." Let me ask Dr. Nyman if any of these tests would have avoided the error in the case of gastric ulcer just described. Except cardiac examination and radiography, these are systemic readings and do not identify dental infection with a more generalized disease. Perhaps it was enthusiasm that led me to make the remark that we would find only one case of gastric ulcer in every 10,000 patients with dental infection. However, dental infection is unfortunately almost universal during some period of adult life, while gastric ulcer is rare. So let me repeat my slogan. If we are going to remove all pulpless teeth merely by rule of elimination, we are going to sacrifice 9,999 teeth to cure one gastric ulcer.

As to patients with diabetes, to which Dr. Nyman refers: let me say that I would much rather have the patient first treated for diabetes and then extract the infected teeth, than to extract the teeth and then treat for diabetes, for it is well known that sockets of infected teeth heal poorly or not at all in diabetics. Dr. Nyman advises taking blood for the sugar test before breakfast and for the blood count before luncheon. If at all, why not both before breakfast? The blood count is as much influenced by a meal as is the sugar. I am of the opinion that no systemic test has yet proved of value in a consideration of the treatment of dental infection. If positive, that is, not normal, the test is of negative value, for it does not

connect the dental infection with the systemic disease. However, if the systemic tests are normal, we may regard the prognosis of dental infection more favorably, and to that extent only are these tests of value.

If a patient comes to us with an infected tooth, I do not believe that the dentist has moral right or license to treat that infected tooth without consulting the patient's physician, who should be informed of any infection that we may be able to diagnose. Systemic findings as to the patient's general health are of interest to the physician, but we as dentists are not interested in them except as they may pertain to the general health of the patient. They cannot influence us in our dental work unless they are negative. If the patient's health is good, then we may consider the prognosis of dental treatment of these infected teeth more favorably.

Now, it occurred to me that in the breaking down of the tissue cells some toxins may be formed that we do not get from the organisms grown upon artificial media; also that there may be a difference in the types of toxins from these organisms grown upon artificial media, that is, outside of the body. Dr. Daland, I believe, brought up the same question. We dentists, dealing as we do with circumscribed infections, very frequently find that the granuloma comes away with the extracted tooth. When this occurs, I make the following tests: I first make a culture from the granuloma. Then I carefully resect the granuloma from the tooth root and place it into a few drops of sterile saline solution. This granuloma is then rendered sterile by heat in the same manner as are the organisms grown upon artificial medium. When the latter organisms are ready, we make our test injections. A control injection is made of just the saline solution. An injection is made of the vaccine, that is, the organisms that have been grown upon an artificial medium. Then an injection is made of the organisms obtained from the granuloma by inserting a needle into it and removing material sufficient (organisms and liquified cells) to produce a skin reaction. Finally, an injection is made of the saline solution in which the granuloma had been placed—there may be some soluble toxins in it. Of course, we have not had that sterilized saline solution filtered and there may be some dead organisms present, which may be responsible for reaction. But whether we will get a reaction from the dead organisms obtained directly from the body of the patient is our chief concern. Whether we are dealing with toxins in our reaction, I am not ready to say, but so far I am satisfied with my results based upon the reactions.

We have found that when we get a reaction to the organism grown upon artificial media, we always get a reaction to the organisms grown in the granuloma. Now it is strange to relate that the case illustrated in

fig. 5, represents the strongest reaction that we have had from a granuloma and this reaction reached its height at about the eighteenth hour. Up to the present, we have not had a strongly positive or a positive skin-reaction from teeth with granulomas, which shows that the granuloma is evidence of resistance in the patient. Of course, where we have a local resistance, antibodies are formed. The granuloma is evidently a manifestation of a *local* resistance—a view that is also supported by our clinical findings. Frequently we extract teeth with definite radiographic evidence of infection—the granuloma—and there is no improvement in the health of the patient. Again, we will have a patient with a tooth that is radiographically negative, but are suspicious that the tooth may be pulpless, which is confirmed only by an electrical or a thermal pulp-vitality test, or by transillumination. We remove the tooth and the patient immediately recovers. Why? There is no local tissue resistance. Such a condition is most dangerous, and I believe that the skin test will at least prove this contention. Therefore, I believe, it is the teeth that are radiographically negative that need special attention. If this be true, how are we going to know when we may save these teeth? We know that the percentage of sterile pulpless teeth is exceedingly low, so that either the pulpless tooth is condemned to the forceps or else we must find some means of saving these teeth. To this end I offer my skin-reaction test. As I have stated, the test may not be exact and probably has its limitation, yet we may gather some information of value by its use.

Robert A. Cooke, M.D. (*New York City*): I shall first discuss, from the scientific or theoretical viewpoint, the immunological problems that have been presented, and then mention some of the practical aspects of focal infection as they appeal to the medical man. As has already been stated, the problem of immunity is very complex and, judging from the discussion, there is a good deal of misconception of immunological terminology. As a matter of fact the term *immunity* embraces a great many different biological reactions, such as the formation of antitoxins, bacteriolysins, anti-hemolysins and opsonins. When the word *antibody* is used, therefore, we must realize that it is only a generic term. The antibody to a toxin is an antitoxin, and is very different from the antibody to bacterial protein and bacterial products called bacteriolysins. By the same token we must realize that the reaction to a toxin is not at all the same thing as a reaction to bacterial protein. Therefore, the knowledge we have, and the use we make of toxin tests, cannot be applied to tests with bacterial substances either in solution or in suspension as vaccine.

I can best illustrate these remarks on immunity by calling attention to tests in certain well known diseases. Typhoid fever is an infection that generally produces a permanent immunity after the disease. However, there is no bacteriologist or immunologist who can tell, out of any group of persons, those who have had typhoid fever and who are immune, from those who have not had it. In other words, there is no known method by which one can determine the presence or absence of immunity to typhoid, and yet it is a very definite thing. If a group of individuals is tested with typhoid protein, or with typhoid vaccine after the manner that Dr. Kauffer has employed in his tests with other vaccines, positive skin-reactions may or may not occur in immune individuals, and positive as well as negative reactions may be obtained in the skin of individuals who have never had typhoid, or are not known to have had it. The test is not a criterion of the immune state. The manifestation of agglutination is often not present, and there is no known method by which we can determine immunity, or lack of it, against the typhoid bacillus. This illustrates one immunological problem to which we have no solution.

Diphtheria is a pure toxin disease. The diphtheria bacillus is one that produces an exotoxin very readily with ordinary culture media. *The Schick test is a toxin test.* It is a test made with diphtheria toxin, not with the protein or the bacillus. The absence of a skin reaction merely means that there is an antitoxin in the body of the individual neutralizing the toxin in the test. Diphtheria is about the only disease in which we can satisfactorily demonstrate the presence of an immunity, and know why and how the immunity exists. This toxin reaction is not a vaccine test, and bears no relation to one. The recent work of the Doctors Dick, of Dochez, and others, on scarlet fever is quite analogous to that on diphtheria in that a streptococcus toxin is demonstrated, and immunity arises from an antitoxin.

The tuberculin test, for tuberculosis, is made by the introduction into the skin of "old tuberculin," which is a solution of the bodies of the tubercle bacillus, plus the products of their growth. It contains no known toxin. We get a reaction in an individual who has been infected by the tubercle bacillus, but a positive reaction gives us no idea about the state of immunity of the individual. It merely shows that that individual has been infected by the tubercle bacillus. No conclusions whatsoever can be drawn as to the state of his immunity. So you see, the skin tests as used for an estimation of immunity or lack of immunity toward specific infections, have a very limited applicability and are satisfactory only in those instances in which we deal with a true toxin, as in diphtheria.

When bacteria are grown on ordinary culture, media for the preparation of a vaccine, toxin is not produced. Consequently, when bacterial bodies in suspension are used for a test, it is erroneous to assume that the knowledge of toxin and antitoxin reactions is applicable to such a vaccine test.

The reaction that Dr. Kauffer employs is a reaction obtained to a suspension of bacterial bodies without toxin. Therefore, a positive reaction can indicate only what we might call an allergic or a hypersensitive reaction to the bacterial protein. It has nothing to do with the toxin, and is analogous to the tuberculin test. It tells us nothing with regard to the state of immunity of the individual, but merely shows that the individual has been infected with the particular organism used in the test. It does not indicate that the patient is infected with the organism at the time of the test. It does not indicate that the resistance is great or little. It merely shows that such an infection, such a hypersensitive state, has been set up. It is very well known that there is no toxin present in vaccines as they are produced today. The streptococcus toxin and, more recently a staphylococcus toxin, are produced only from these organisms when grown on very special culture media under particular conditions. It is a great mistake to talk about demonstrating immunity antitoxins and other antibodies when we use vaccine tests.

I know that there has been a great deal of work on vaccine tests, in an attempt to throw some light upon the problem. Of course, these various studies of immunity are worth while, because even though the results are negative, they give us some information. But when we come to interpret reactions on bases that are not strictly accurate—when we try to make practical application of a thing about which little is known—it seems to me that we are treading on rather dangerous ground. While this work should be done, it must be done, of course, as a scientific investigation and not directly as a thing to be presented to the profession for general or practical use. No physician would attempt to diagnose diseased tonsils with a skin-reaction test that was or was not positive to a vaccine made of a culture of the tonsil. This situation is entirely analogous to that which Dr. Kauffer has suggested for dental infection. We diagnose tonsillar infection on visible evidence of infection and not by test. The use of a vaccine test for this purpose, at the present time and in the present state of our knowledge, would be a great mistake.

Dr. Nyman and Dr. Kauffer have both emphasized the fact that the effects of infective foci in the body are manifold. If we indicated the diseases that, directly and indirectly, are the result of infective processes, we would practically name 90 per cent of the diseases to which mankind is

heir. So that the question of focal infection is of vital importance, and particularly the chronic infections which are hidden and give no direct symptoms. If there is a question of focal infection in the presence of systemic disease (and by that I mean any of this group of diseases that Dr. Daland has already mentioned), I believe that we are justified in eliminating all discoverable foci. I cannot persuade myself to believe that we should be justified in resorting to any kind of expedient or test to save one or two teeth, or tonsils, or any other organ, if a focus can be discovered and eliminated. However, the physician meets a much more difficult problem when focal infection is present in the absence of known systemic disease. I think that, then, as medical men, we must assume an attitude that is sensible—neither too radical nor too conservative.

We must realize that we cannot diagnose incipient disease. We have four or five times as much kidney tissue as we need, and before we get evidence of kidney disturbance by any known test nearly four-fifths of the kidney tissue has been destroyed, and it is too late. In other words, as we try to practice preventive medicine today, in its best form, we should look upon focal infection in the light of what we know *will* happen. Under these conditions, it seems to me, the only safe attitude is to be sure that every focal infection is removed, irrespective of the fact that the patient is apparently well. If we remove foci at the time he is well, we have done something worth while. Neither patient nor doctor ever knows "what would have happened." That side of the story is never told, but in the course of time the value of this sort of management will be brought out by an improvement in the vital statistics from the health departments of various cities and states. At present, we are going through an era of focal infections. Our forebears had bad teeth, and they had them out. Then came the time when filling of teeth was generally resorted to, and we are now a part of the generation that suffers from dental infections. But I think that a better day is about to dawn, not only because of the attitude of the medical profession with regard to preventive medicine, but also because of the attitude of the dentists with regard to their preventive treatment. Teeth will never be allowed to become infected, as they have been in the past, and in the rising generations these dental infections will not even exist.

Dr. Nyman (*in conclusion*): Recently I spent two hours with Dr. George Dick of the McCormick Institute, and he related some of his newer work. Dr. Dick has made attempts with every known method to obtain a culture and a toxin from cases of malignant endocarditis or ulcerative endocarditis,

where he felt that the organism had been isolated, because, by injection of cultures of that organism into animals, ulcerative endocarditis could be produced in nearly every instance. Despite all his experience in developing and using toxins for skin tests, he was not able to obtain a toxin by which, in a single instance, he could produce a positive skin-reaction, even in an individual having malignant endocarditis and who was dying of it. The same condition exists in cases where he had succeeded in isolating the organism that seemed to have a selective affinity for the joints. In a large majority of the lower animals in which he injected this culture, or its toxin, arthritis was produced repeatedly. Yet by no known method, with all his experience, could he produce a toxin with which he could obtain a positive skin-reaction in the individual that he knew had infective arthritis.

In regard to Dr. Cooke's comment on the Dick test—that there are some foreign proteins there—I should like to emphasize the fact that every effort is made to exclude them. They are filtered three times, and then an effort is made to grow cultures from the final toxin, of which the skin-test dose is made. Dr. Dick is unable to obtain, under any oxygen or vapor conditions, a culture from the filtered toxins upon any of the media with which he develops the skin-test toxin. However, by increasing the dosage one hundred times that of the skin test, a typical case of experimental scarlet fever can be produced in a susceptible individual by that steril toxin. I realize that, despite all these filtrations, some of the protein toxins may filter into the final toxin product; but, as far as can be determined, there is no more protein toxin in culture-developed scarlet-fever test-toxin, than there is in the diphtheretic toxin used in the Schick test.

Dr. Charles Mayo was suffering from neuritis in his right arm, which he feared would incapacitate him for operating. He had no evidence of infection in the teeth, the tonsils gave no marked evidence of infection, and no infection could be found any place in his body. He finally said, "I want the tonsils taken out." They were removed, and there was found in the medulla of the left tonsil an area of infection that was only about 2 cm. in diameter. His neuritis disappeared, and he succeeded in producing neuritis in every animal that he injected with cultures obtained from that infection. Dr. Rosenow had a similar experience. Eight years after an upper molar had been extracted, and when he was still suffering from the the same trouble that he had been having, although not as intensely, the old area was reopened and there was found an osteomyelitic area with a residual section of the granuloma. The soft tissues had originally closed over quickly, and the enclosed infection was retained in that spot, although

not to so great a degree. When the residual infection was removed, his malady cleared up.

I wish to express my appreciation and gratification of the discussions by all the men who have taken part. I am very much gratified to know that Dr. Kauffer realized that further tests and experimentation, with various other modifying influences, must be made to evaluate his skin test. If his skin tests had shown positive results that approximated what we have found by clinical experience, I might have felt more convinced about it. His percentage was so low, as compared with the known percentage from clinical observation, that I felt there must be very grave doubt about it. I have regarded it, as Dr. Cooke does, as a protein sensitization reaction instead of an immunity toxin-test.

I wish to correct the apparent misunderstanding concerning one feature of my paper. I did not state that, if antiseptics were used to dissolve root fillings, they would have a modifying effect upon the microörganisms and toxins in the unfilled portions of the canal or periapical regions. What I did say was that all the solvents for the various root-canal fillings have an antiseptic action. Furthermore, I believe that in certain classes of root canals, where the anatomy is favorable and where the previous clinical history is not unfavorable—and where the systemic condition of the patient is approximately normal—root canals may be effectively sterilized and may, by modern methods and with modern root-filling materials, be so filled as to preclude reinfection. The fact that root-canal and periapical infection has been demonstrated, after extraction of many teeth that radiographically were apparently well filled, does not prove that this cannot be successfully accomplished in the type of cases I have just mentioned. In most instances of such extractions there is no dependable clinical history as to the pathological condition of the teeth prior to filling; or the character of the treatment; or the materials and method, including the aseptic precautions, by which they were filled.

Dr. Daland spoke of the elevation of the dental profession resulting from the recognized importance of dental infections as focal infections that are related to serious systemic involvement. There is no question about that. The public has not regarded our profession as seriously as it should for the reason that any tooth that had to be removed didn't mean much of a loss because it could be replaced one way or another, so that the restoration was as perfect as one could ask for, both in appearance and in function. But, as I have pointed out, and as Dr. Daland and Dr. Cooke have emphasized, you can't replace joints, optic nerves, retinas, kidneys, and heart valves. Because patients, suffering from diseases that may cause

permanent disability or death, go to medical men for treatment, physicians and the practice of medicine have been regarded so much more seriously than dentists and the practice of dentistry. However, the public is now being educated to realize the serious and sinister relation existing between dental infections and the systemic diseases that may cause permanent disability or even death. In consequence of this education they will regard more highly and with more respect the profession of dentistry, and also realize that in its essence it is a speciality of the great general profession of medicine.

ELASTIC FIBRES IN PERIDENTAL MEMBRANE AND PULP[1]

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This paper must be regarded as a preliminary announcement and not the result of a completed program of research. Although the statements of histologists uniformly agree that there are no elastic fibres in the peridental membrane, the writer was led to doubt them because of the general distribution of such fibres in kindred structures, as well as the suspected appearance of fine elastic elements in occasional specimens stained with hematoxylin and eosin, and used for laboratory teaching purposes. I concluded to test this possibility with elastic-tissue stains, and began with Weigert's resorcin fuchsin. Previous to an attack on the real problem, and much as a drill in the use of the stain, I employed the jaws of a dog, from which the findings presented in this announcement are wholly derived.

In 1867 Kölliker (1) declared that the membrane contained "no elastic fibres," and from his time to that of Black he was quoted almost universally. In 1887 Black (2) repeated the dictum, and from that date to this he has been quoted in preference to Kölliker. He said "the fibres of the peridental membrane are wholly of the white or inelastic variety." Three years ago Scheff (3) affirmed that "élastic fibres are wanting." None of these writers tells his methods of determination. Certainly no such gross elements as those appearing in the gum mucosa, or in the cortical periosteum, could be present or they would not have escaped notice.

In an introductory way I would call attention to the fact that the peridental membrane is a modified periosteum, and should be classified with the endosteum and dura mater as such. Its position between two surfaces to which it is genetic gives it the character of the inner layer of the periosteum. Sections showing alveolar process, membrane, and tooth will illustrate this clearly enough. The fine fibres

[1] Read at the fifth general meeting of the International Association for Dental Research, Hotel Plaza, New York City, April 19, 1927.

of the inner periosteal layer pass over the alveolar crest and blend, without demarcation so far as the size of the fibres is concerned or their staining proclivities, with those of the membrane. Beyond this point and its osteogenetic function, the peridental membrane has no morphological resemblance to the periosteum. Occasionally attempts have been made to split it into two and even three layers (4), but without much success. It is, distinctly enough, single layered and is genetic of calcified tissues on its two surfaces. The arrangement of the supporting apparatus of the tooth destroys all structural similarity, and its content of epithelial cells is characteristic of it alone.

The specimen in question showed elastic fibres abundantly scattered throughout the peridental membranes of all the teeth in the jaw. They were fine, and arranged usually in the plane of the white fibres, which they sometimes accompanied, but they also showed complete absence of arrangement in place. They were most abundant among the principal fibres at the point of their bifurcations a short distance from the tooth surface, and in the indifferent tissue filling the triangles caused by the spread of the fibres, which areas contained the large vessels and nerves. They did not appear in the tissue in contact with either tooth or bone.

The elastic elements are comparable in diameter with similar fibres in the media and adventitia of smaller vessels, some of which appear in the membranes examined. All the vessels in these structures, beyond the capillary stage of development, showed an elastic-tissue content similar to that of vessels of comparable sizes elsewhere. In like manner the adventitiae of the larger pulpal vessels contained elastic fibres, all of them staining with as much precision as the elastic membrane of the arteries in the pericementum, or the inferior dental canal, or the grosser fibres of the gum mat.

The tissues used were taken from the shelves without any selectivity. The age of the animal was unknown. The material had been fixed in formalin. The appearance of yellow fibres in a specimen taken so much at random is significant.

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SOME ASPECTS OF MODERN DENTIFRICES[1]

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I. INTRODUCTION

That the dental profession is beginning to feel the necessity of knowing something about dentifrices is evidenced by the number of articles which have been appearing in the current literature. But none of the arguments advanced in all those papers will so convince the average practitioner of his own lack of definite knowledge regarding this subject as will the simple question of his patient: "What tooth paste would you advise me to use?" As any answer that may be forthcoming is often based on vague conceptions, the public is left to its own devices in the selection of a dentifrice.

In this connection it is illuminating to refer to a paper read before the Massachusetts Dental Society, in 1913, by Professor H. C. Kelly (4). He stated that he had been questioning the students at the Central High School, Springfield, for a number of years regarding the

[1] Report of experimental work done in laboratories of the College of Dental Surgery, University of Michigan (1921–22). In fairness to the manufacturers of the preparations named, the possibility that meanwhile some of these products have been improved should not be disregarded. On the other hand, they may now be more abrasive.

tooth preparations they had been using. The answers were practically identical year after year. About 94 per cent replied that they were using some kind of a preparation. Of these, 33 per cent did not know what they were using; 60 per cent ventured no reply as to why they were using any particular preparation, and of those who did 65 per cent admitted that their predilection for any particular kind was based on its pleasant taste. Ancient data we admit, but if the public is any more meticulous in its selection of a dentifrice today, it is to be ascribed to the extensive advertising propaganda of the manufacturer. And that dentifrice is the most popular which is the most extensively advertised and offers the greatest number of "talking points."

How far some of these advertised claims are justified has been investigated by William J. Gies, in the Biochemical Laboratory of Columbia University (1).

Among the preparations which he has subjected to inquiry are Pepsodent Paste, and Mennen's Cream. The manufacturers of Pepsodent claim that unusual results are obtained by the use of Pepsodent, owing to its power of dissolving mucin films from the teeth. With this object there is incorporated in their paste a certain amount of pepsin, which, when suitably activated, is a proteolytic ferment. In order to secure this activation of the pepsin, they rely on the addition of acid calcium phosphate to the paste. Gies summarized the results of his investigation by stating that Pepsodent does not possess appreciable digestive power on dental mucin plaques, when applied to the teeth as a dentifrice. "The pepsin in Pepsodent is too small in proportion or too weakly assisted by the acidity of the Pepsodent, or both, to enable Pepsodent to show more than insignificant action on mucin and other proteins, under the most favorable conditions of temperature, time and concentration." Thus the advertised basis for the activity of Pepsodent is completely swept away. This, however, does not mean that the above preparation is wholly without virtue as a dentifrice. The cleaning and polishing property which it undoubtedly has, is due, however, to the abrasiveness of the acid calcium phosphate. How abrasive this paste is we shall see later.

Mennen's cream dentifrice claimed to be "acid in reaction, stimulat-

ing the flow and alkalinity of the saliva so that between times, all day and all night, the marvelous protective work of nature can go on." This is supposed to be in accordance with Pickerill's principle that alkaline dentifrices and mouth washes for the prevention of dental caries must be abandoned. The investigations of Gies and Karshan (2) show that this cream, instead of being acid in reaction, has a high degree of alkalinity, and that the claims made that (a) it is acid in reaction, and (b) that through the agency of acidity this dentifrice breaks down deposits of tartar and mucin plaques, and (c) that it stimulates the flow and increases the alkalinity of the saliva, are wholly unwarranted.

So much for the reliance that can be placed on the claims of some manufacturers. From these two examples we are driven to conclude that the advertised claims of dentifrices do not form a sound basis for the selection of a mouth preparation. Be that as it may, it is the duty of our profession to assist the public by advice based on a rational consideration of the principles involved in the action of a dentifrice.

II. METHODS OF CLEANING TEETH

Webster's new International dictionary defines a dentifrice as "a powder, paste, or liquid used for cleaning the teeth." The purpose being thus defined, we have to consider at the outset the two methods by which it may be secured: chemical and mechanical.

Chemical methods. Under this heading we include those agents which are intended (a) to soften and break down deposits around the teeth, or (b) to inhibit bacterial flora and thus assist in the prevention of caries (antiseptics); and (c) those having a physiological action on the salivary glands.

(a) Acids, alkalies, soaps. Certain agents are capable of disintegrating dental plaques by exerting a chemical action on the proteins. Those so far advocated are acids, alkalies, and soaps.

The mucinous matter sticking to the teeth consists in part of mucin and in part of mucinates, that is to say of a protein acid and its salts of sodium, potassium, calcium, etc. An *acid* added to this mixture, withdraws the base from the salt and produces mucin. The latter being insoluble in a slightly acid medium is precipitated, as non-

adhesive flakes which may be brushed from the teeth. Gies represents the action thus, in general symbols (3):

$H_{x-2}Na_2M$	+	2HR	=	H_xM	+	2NaR
Disodium mucinate		A soluble acid		Mucin (insoluble)		A soluble salt

Of the three agents quoted, it seems that acids act the most efficiently, but their use is attended by certain disadvantages which cannot be ignored. To exert complete disintegrating action their acidity must be maintained during the period of application. Thus while the acid acts on the mucinous matter, it may be also attacking the tooth structure. This attack may be manifested by decalcification, or by increased sensitivity of the teeth. The degree of decalcification is, of course, dependent on the acid employed and the concentration in which it is used. But however slight the decalcification may be, it should especially be shunned where the teeth are poor in structure or where there is a tendency to erosion. Increased sensitivity may only be seen in certain mouths, but is so marked with some people that they cannot tolerate the use of acid preparations for even a short time.

Keeping the above considerations in mind, it would not seem advisable to recommend the free use of acid dentifrices. However, when the saliva is thick and sticky a suitable acid dentifrice might be prescribed, for limited periods, till the mouth has been put in a good condition of oral hygiene.

An *alkali* acts on mucin by combining with it, forming a mucinate, which is soluble, though comparatively slowly, in an excess of the alkali but may be adhesive. This excess, which is necessary for effiicient cleansing, may exert a harmful action on the soft tissues. The alkaline mouth-wash usually recommended is lime-water, but it should only be used in very dilute solutions.

Soaps act by emulsifying food debris, precipitated mucin, freshly deposited tartar, etc. A soap seems to be a valuable adjunct provided that it be used in sparing quantity. A good oral preparation should not contain more than 5 per cent of the purest grade of neutral soap. Used in excess, soaps are strong astringents and undoubtedly have a harmful effect on the mucous membranes of the mouth.

(b) Antiseptics. A great variety of antiseptics is incorporated in the tooth pastes on the market, and constitutes some of their strong "speaking" points. Suffice it to say that numerous investigations have proved that, in the strength in which such antiseptics may safely be used in the mouth, they are of doubtful value. Miller showed that even where the mouth had been sterilized by the use of strong antiseptics, it became reinfected from the air within twenty minutes or less. We must conclude that the incorporation of an antiseptic into an oral preparation is not of prime importance, and may well be omitted.

(c) Agents which exercise a physiological action on the salivary glands. Of these, acids have received the widest attention owing to the publication of Pickerill's work on the "Prevention of Dental Caries." Pickerill recommended the use of an acid mouth-wash (acid potassium tartrate). He based his recommendation on experiments which demonstrated that suitable acids stimulate the flow and increase the alkalinity of the saliva. This undoubtedly is true, but we might well regard this as a natural reaction of the body against an injurious agent; it would seem that the copious induced flow of the saliva, and its increased alkalinity, is nature's attempt to protect the oral tissues: first by diluting, secondly by neutralizing, the irritant (acid).

If dental caries is to be controlled by changing the character of the saliva, then this ought not to be brought about by repeated local stimulation of the salivary glands, but rather by methods which will improve the general metabolism of the body as a whole. Perhaps the future will reveal some system of dieting by which this may be accomplished.

Mechanical means. A liquid preparation may be used simply as a mouth wash, in which case any mechanical cleansing action is due to the agitation of the fluid, and to the movements of the cheeks, lips, and tongue. Obviously this alone is inadequate. More effective measures consist of brush, plus a powder or paste containing an abrasive. Powdered pumice, cuttle fish, oyster shell, prepared chalk, etc., have been used in various preparations. Precipitated calcium carbonate appears to be the favorite abrasive today, but the others have by no means gone out of use.

III. ABRASIVE QUALITY OF SOME DENTIFRICES

Procedure. It was with the idea of arriving at some knowledge of the abrasive action of present-day tooth pastes and powders that a series of experiments was conducted in the laboratory of Dr. Russell W. Bunting, at the University of Michigan. For this purpose a machine was designed which would apply the dentifrice in such a manner that all experiments would be conducted under similar conditions. The machine consists essentially of a horizontal bar, actuated by a fly wheel. To this bar is attached three sleeves in which vertical arms slide. At the lower end of each arm is a device for attaching any ordinary tooth brush. As the fly wheel rotates, a reciprocating motion is imparted to the horizontal bar and the brushes are caused to move, to and fro, through a stroke of 1.5 inch. The number of strokes imparted to the brushes is indicated on an automatic counting device.

Freshly extracted teeth, preserved in a solution of formaldehyde, were used to determine the abrasive action on enamel. The teeth selected for use were cuspids and bicuspids. These teeth were ground flat on the lingual surface and the maximum labio- or bucco-lingual diameter measured very carefully, by means of a micrometer gauge reading to $\frac{1}{1000}$ of an inch. The diameters having been measured, the teeth were fixed in brass containers by means of impression compound. They were so placed that the brushes would move over them in a direction perpendicular to the long axes of the teeth. The brushes used were a good type of ordinary tooth brush, from which the handles had been removed. These brushes were adjusted so that a uniform pressure was exerted in all instances. This was obtained by allowing the vertical arms to ply freely in their sleeves, running the machine through a few strokes till the natural spring of the bristles was just supporting them on the teeth. Then each arm was moved down $\frac{1}{8}$ inch and firmly clamped. The arms were readjusted every half hour and the brushes trimmed to a flat surface every hour.

Both powders and pastes were mixed with water, to a consistency as nearly alike as possible. The brushes moved along a trough in the base of the container, so that they tended to maintain the uniform consistency of the mixture, by preventing any solid particles from settling to the bottom. The number of strokes used was 100,000 double, i.e., 200,000 single strokes, at an average rate of 320 strokes

per minute. The person who brushes his teeth at all conscientiously will easily subject each tooth surface to thirty double strokes a day, or roughly 10,000 a year. Thus 200,000 single strokes would represent approximately ten years' brushing. The result of this amount of brushing was tested out with a number of the more common dentifrices. These were selected and bought at the nearest drug store.

Effects on enamel. With all of these preparations it was found that the abrasion on the enamel at the point of measurement was exceedingly slight. But does this mean that the abrasion of enamel in the mouth after such a period of brushing will be slight? By no means. Clinical experience has shown that severe damage may be done in the course of a few years by the vigorous use of brush and abrasive. Obviously the character of the saliva is no negligible factor and it must be borne in mind that the results herein stated are those of experiments outside of the mouth.

In contradistinction to the abrasion at the point of measurement was the abrasion at the cemento-enamel junction. Often deep notches were cut here. In the case of the more abrasive pastes, this notching was so deep as to have exposed, or even to have cut past, the pulp chamber. This shows that considerable danger may attend the use of the more abrasive preparations, in cases where the bristles of the brush are likely to engage with the cementum. On examining these teeth with a lens, the enamel did not in any case show evidence of scratching, but the incremental lines seemed to be slightly accentuated.

Appended are the results showing the wear on the enamel at the point of measurement, i.e., in the neighborhood of the buccal bulge of the tooth (expressed in fractions of an inch).

Carmipyo powder	0.004	Vident 2 powder	0.0005
Pepsodent paste	0.004	Euthymol paste	0.0003
Lyon's powder	0.0015	Kolynos paste	0.0000
Vident 4 powder	0.0015	Pebeco paste	0.0000
Colgate's powder	0.0013	Chlorox paste	0.0000
Lyon's paste	0.0005	Carmi lustro powder	0.0000
Colgate's paste	0.0005	Prophylactic powder	0.0000
Dr. Jungmann's powder	0.0005	Listerine powder	0.0000
		Vident 3 powder	0.0000

The more abrasive pastes were checked a number of times and the above figures give the average results.

Effects on bone. In order to establish the rate of wear on a substance like dentine, bone blocks were cut from the handles of one make of tooth brush. The bone as nearly as could be determined appeared identical in all of these. These bone blocks were soaked in water for sixty hours, no appreciable swelling of the bone having taken place. They were then subjected to brushing with the same preparations as were employed on the enamel, using, however, only one fifth of the number of strokes, viz., 40,000 single strokes. The blocks were measured at three points, spaced $\frac{1}{8}$ inch apart, before and after making the test. Three measurements were necessitated by the uneven wear of the block. In each case the average of the set of three measurements was taken.

The following summary shows the amounts of abrasion (expressed in fractions of an inch).

Vident 4 powder	0.052	Colgate's paste	0.024
Pepsodent paste	0.046	Prophylactic powder	0.021
Lyon's powder	0.041	Pebeco paste	0.020
Colgate's powder	0.039	S. S. White paste	0.020
Carmipyo powder	0.036	Euthymol paste	0.019
Vident 1 powder	0.035	Kolynos paste	0.016
Vident 2 powder	0.032	Chlorox paste	0.015
Vident 3 powder	0.031	Listerine powder	0.013
Lyon's paste	0.024	Water alone	0.000

The data show that the order of abrasiveness for the enamel is not the same for the bone. In other words, a preparation may be very abrasive for a substance like bone or dentine, yet comparatively far less abrasive on the enamel.

Effects of one powder on the enamel of different teeth. It was thought that this apparent discrepancy in the results between enamel and bone abrasion might be due to differences in the hardness of the enamel. This was tested on six teeth, selected to differ as much as possible in color and opalescence. Colgate's powder was employed as the abrasive and 200,000 single strokes were applied with the same brand of tooth brush. No appreciable difference was seen in the resulting

abrasion. This confirms Miller's work (5), which demonstrated that there was no difference between the abrasion exerted by the same agent on different teeth.

Summary. As has been pointed out, the abrasion of sound enamel as effected by these preparations is slight. In order, then, to arrive at a classification of the above dentifrices, according to abrasiveness, it seems more reasonable to use the results shown on the bone, since these indicate the action that may be exercised at the point of greatest vulnerability. From these results it appears that there are three grades: markedly abrasive, moderately abrasive, and non-abrasive or practically so, as grouped below:

I. Abrasive	*II. Medium*	*III. Bland*
Vident 4 powder	Vident 1 powder	Prophylactic powder
Pepsodent paste	Vident 2 powder	Pebeco paste
Lyon's powder	Vident 3 powder	S. S. White paste
Colgate's powder	Lyon's paste	Euthymol paste
Carmipyo powder	Colgate's paste	Kolynos paste
		Chlorox paste
		Listerine powder

Although these preparations have been listed as named, there is no assurance that the manufacturers are turning out a uniform grade of preparation. Some seem to have awakened to the fact that their preparations are too abrasive.[2]

Miller demonstrated, in his work on erosion, that it was possible to wear away the enamel and dentine completely, as far as the pulp chamber, with only eighteen hours' brushing, and the use of certain powders and pastes then on the market. Today we do not meet with such terrible abrasives in the dentifrices commonly employed. It is thus possible that the articles listed may change their relative position, but as nearly as could be determined such is their position today.

IV. SELECTION OF A DENTIFRICE

So variable are the conditions in the mouths of different individuals that no dentifrice can meet all requirements. The dentist should carefully study each case and advise the use of such a preparation

[2] See the second sentence in foot-note 1, on the first page of this paper.

as is adapted to the needs of the individual patient. And it is in this connection that the classification of dentifrices according to their abrasive power will prove of material aid in their selection. Thus a marked abrasive is often needed with such indications as (a) habitually unclean mouth; (b) thick and sticky saliva; (c) tendency to form calculus. But such marked abrasives as are listed in class I can only be prescribed where, in addition, there is no tendency towards erosion and where the tissues around the teeth are sound and adequately cover the cemento-enamel junction. Having been advised to use such an abrasive preparation the patient must also be cautioned against brushing across the teeth. Further, when his mouth has been put in a condition of good oral hygiene, he should be instructed to abandon the more abrasive preparation for a bland or medium paste or powder.

Medium or bland preparations such as are listed under classes II and III are indicated (a) in all cases where there has been a recession of the tissues around the necks of the teeth; (b) where erosion or wasting of the teeth is in evidence; and (c) where the mouth has been put in a condition of good oral hygiene and tends to be self cleansing.

Andringa Street[3]

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[3] Now 9154 Mack Ave., Detroit, Michigan.—[*Ed.*]

AGGLUTININS IN SERUM AND SALIVA OF RABBITS INOCULATED WITH B. ACIDOPHILUS

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I. INTRODUCTION

Recent dental researches have kept studies on B. acidophilus significantly in the foreground. Among these investigations are many having as their theme the relation of this bacillus to dental caries. Goadby (5), Kligler and Gies (10), Howe and Hatch (9), McIntosh, James, and Lazarus-Barlow (11, 12), Rodriguez (15), Bunting and Palmerlee (3), and Bunting, Nickerson, and Hard (2) have given this aspect of the subject special attention. Bunting and his coworkers, in their last report (2), state that, "in a survey of 427 cases of caries susceptibles and caries immunes there was a correlation of the presence of B. acidophilus in some form, to the presence or absence of dental caries, in over 98 percent of the cases, which observation strongly supports the view that dental caries is an infective disease and that B. acidophilus in some form is a specific bacterial factor."

With so many data pointing to B. acidophilus as an etiological factor in caries, and with the growing interest in the use of autogenous vaccines in focal infections,[1] it seemed desirable to ascertain whether the saliva and blood serum of rabbits inoculated with dead B. acidophilus organisms would contain any immune body specific for this germ. The present paper treats of this possibility.[2]

II. THE CHARACTER OF THE ORGANISM

1. *Source.* Two strains of B. acidophilus were employed. One was obtained in pure culture from a "B. acidophilus milk preparation"

[1] Recently Faught (4) has called attention to the favorable results obtainable with such preparations.

[2] While our work was in progress McIntosh, James, and Lazarus-Barlow (13) published some data on this subject.

supplied by the Lederle Laboratories, New York City, and is designated "L." The other strain, "D_3," was isolated from material taken from carious teeth. Dr. E. Alan Lieban, of New York City, helped us with the clinical manipulations in obtaining it.

2. *Preparation of media used in determining the biochemical reactions.* (*a*) *Sugar free broth.* About 75 grams of Bacto-veal in one liter of tap water were heated in an Arnold sterilizer for two hours. The resultant coagulum was allowed to settle spontaneously and the infusion strained through a wire sieve. The hot bouillon easily dissolved 10 grams of peptone and 5 grams of NaCl that were added to it. An aliquot part (10 cc.) was cooled and adjusted to a 7.4 pH. The calculated amount of *M* NaOH was added to the remainder, and the mixture placed in an Arnold sterilizer for 15 minutes. Treatment with B. coli communis, the conventional procedure to free the infusion from sugar, was omitted for this reason: muscle tissue, from which Bacto-veal is manufactured, contains only one carbohydrate fermentable by streptococci. This is a reducing sugar: glucose. We tested our infusions with Fehling-Benedict reagent, but consistently negative results for the presence of glucose were obtained.

(b) *Carbohydrate agar.* The chief need for precaution is due to the fact that a sugar in slightly alkaline solution decomposes readily. This occurs to some extent even at room temperature (23–25°C.), but very marked decomposition takes place at the temperature of an Arnold sterilizer or autoclave. Avery and Cullen (1) suggest that it is best to sterilize a concentrated 20 percent aqueous solution of carbohydrate by boiling, 10 to 15 minutes being sufficient.

Bouillon product was prepared by the method described above (2, a) for sugar-free broth. This infusion was then added to 10 grams of agar in a 1500 cc. flask, and autoclaved for 45 minutes at 12 to 15 pounds pressure. To the melted agar were added 25 cc. of Andrade indicator, prepared with one half the amount of alkali suggested by Wood, Vogel, and Famulener (16), of which 10 cc. portions were measured into test tubes and sterilized in an autoclave at 12 pounds pressure for 15 minutes. The sterile sugar solutions were then mixed with the sterile sugar-free agar in amounts to make the desired dilution (1 percent), and the sterility of the resulting mixtures was tested by incubating them for 18 hours at 37°C.

(c) *Meat infusion gelatin:* Hiss and Zinsser recipe, (6) with the substitution of 75 grams of Bacto-veal for one pound of meat.

(d) *Milk:* Hiss and Zinsser recipe (7).

(e) *Nitrate water:* Hiss and Zinsser recipe (8).

(f) *Peptone water:* Hiss and Zinsser recipe (8).

3. *Isolation of strains.* (a) *Strain "L":* as already indicated (II, 1).

(b) *Strain "D_3".*—The fresh material from a carious tooth was planted in whey broth. After 18 to 24 hours of incubation, at 37°C., a loopful was streaked on several whey-agar plates. Single colonies fished from these plates were inoculated into whey broth, incubated, and examined microscopically.

The whey broth was prepared essentially according to Rettger (14), as follows: One liter of milk, after an addition of 50 cc. of HCl solution (approximately normal), was placed in an Arnold sterilizer for 1.5 hours. After the hot liquid had been strained through a wire sieve, 10 grams of peptone were added, and the volume was made up to a liter. An aliquot portion was cooled and titrated to a 6.8 pH. The calculated amount of alkali was added to the remainder, which was then autoclaved for 20 minutes at 15 pounds pressure. Some of the hot liquid which filtered clearly and quickly, was tubed in 5 cc. quantities, and sterilized in an autoclave for 5 minutes.

The whey broth thus prepared was divided into 400 cc. portions, each of which was added to 8 grams of agar-agar in a 500 cc. flask and autoclaved for 30 minutes at 12 pounds pressure. (It is desirable to handle smaller quantities when the agar-agar is being melted, because prolonged heating in an autoclave decomposes lactose in the whey broth.) In this form the whey agar may be stored until needed. For subsequent use, it should be melted in boiling water.

4. *Stock cultures.* At the outset each organism was transplanted from whey broth to whey broth every 24 hours. Longer intervals were allowed to elapse between later transplants, these intervals varying from two to six days.

5. *Seed cultures.* Before a specific culture was to be used, a loopful was planted into whey broth and incubated for 18 hours at 37°C. This is designated as the "seed culture."

6. *Biochemical reactions.* In order that the two experimental strains, "L" and "D_3", might be closely comparable, they were

carried through 150 parallel transplants from whey broth to whey broth. Then seed cultures were prepared. A loopful (6 mm. diameter) from each was transplanted to each of the differential media, which were incubated at 37°C. for three weeks. The results were recorded every 24 hours. *Table 1* indicates the final reactions.

III. IMMUNIZATION

1. *Preparation of the bacterial suspension used to inoculate the rabbits.* (a) *Medium in which the organism was grown.* The medium was the whey-agar described above (II, 3, b), plus 1 per cent of lactose. After being melted, the agar was allowed to cool slowly to 43–45°C., thus insuring a minimum volume of water of condensation in the petri

TABLE 1

Biochemical reactions of two strains of B. acidophilus[1]

STRAIN	REACTION IN											
	Glucose	Mannite	Lactose	Maltose	Sucrose	Raffinose	Inulin	Salicin	Gelatin	Milk	Nitrate water	Peptone water
Culture "L"	+	g	+	+	+	+	g	±	g	+	0	0
Culture from a carious tooth "D_3"	+	g	+	+	+	+	g	±	g	+ s.d.	0	0

[1] Explanation of symbols: + = fermentation; ± = feeble fermentation; 0 = no action; g = growth, no fermentation; s.d. = reaction slightly delayed.

dishes after solidification. This is a necessary precaution to prevent the growth from becoming saturated with water, which would be unfavorable because removal of bacterial masses from the agar surface would be very difficult, and they would be contaminated with substances diffused from the medium.

(b) *Culture.* Of the seed cultures described in section II, 0.5 cc. was transplanted to lactose-whey agar, and incubated for 24 hours, from which two successive subcultures were made to the same medium on two successive days. The last culture was used in seeding the plates for mass growth.

(c) *Suspension.* The growth from the lactose agar was collected as follows: The smoothed end of a microscope slide (spatula) was held lightly but firmly on the agar surface and rotated slowly clock-

wise while the dish was turned slowly counter-clockwise. The growth was thereby gathered on the slide, and could very easily be tapped off into a sterile petri dish containing 0.9 per cent NaCl solution. The suspension thus prepared was standardized against a known erythrocyte count, and diluted to contain the desired number of bacilli per cubic centimeter. Three dilutions were used: (a) 100,000,000 per cc.; (b) 200,000,000 per cc.; (c) 1,000,000,000 per cc.

2. *Inoculation procedure.* (a) *Animals.* Rabbits were used for all of the experiments. The animals, all healthy, weighed between 2 and 3 kgms. They were kept clean and given a varied diet consisting of oats, carrots, clover, grain, and various greens.

(b) *Inoculation.* Usually a day before injection, the hair on a part of the abdomen was removed by means of a depilatory (7 parts of talcum to 1 part of BaS). The depilatory was completely removed to prevent irritation. Immediately before inoculation the region to be employed was rendered sterile with tincture of iodine and alcohol. Each rabbit received between 0.8 and 1.0 cc. of each of the three vaccine preparations. These injections were made at weekly intervals, in increasing concentrations.

3. *Method of obtaining blood and saliva.* Approximately one month after the last inoculation, blood was taken from the heart and saliva was obtained. In order to get a sufficient amount of saliva it was necessary to stimulate the flow by injecting pilocarpin (1.5 mg. per rabbit). The blood and saliva were tested for agglutinins simultaneously.

IV. AGGLUTINATION

1. *Bacterial suspension.* The bacilli were prepared by the procedure described in section III. The suspension was diluted to contain 2,500,000,000 organisms per cubic centimeter.

2. *Dilution of serum.* From 18 to 24 hours after the samples were obtained, several dilutions were made so that the series consisted of undiluted serum; 1 part of serum and 3 parts of 0.9 per cent NaCl solution (1–4); 1 part of serum and 7 parts of 0.9 per cent NaCl solution (1–8); 1 part of serum and 15 parts of 0.9 per cent NaCl solution (1–16); 1 part of serum and 31 parts of 0.9 per cent NaCl solution (1–32); 1 part of serum and 63 parts of 0.9 per cent NaCl solution

(1–64); 1 part of serum and 127 parts of 0.9 per cent NaCl solution (1–128); and 1 part of serum and 255 parts of 0.9 per cent of NaCl solution (1–256).

3. *Dilution of saliva:* Similar to that for serum (IV, 2).

TABLE 2

Results of agglutination tests with serum (illustrative protocol)

RABBIT	DILUTION OF SERUM						
	Undiluted	1–4	1–8	1–16	1–32	1–64	1–128
No. 453	++++	++	+	±	0	0	0
No. 455	++++	+++	+	±	0	0	0

TABLE 3

Total number of sera showing agglutination in the dilutions, and to the extent, indicated[1]

EXTENT OF AGGLUTINATION	DILUTION OF SERUM EMPLOYED							
	Undiluted	1–4	1–8	1–16	1–32	1–64	1–128	1–256
Strain "L":								
++++	0	0	0	0	0	0	0	0
+++	3	2	1	1	0	0	0	0
++	0	2	3	3	2	0	0	0
+	3	2	1	3	4	6	1	0
±	2	2	2	0	3	1	1	0
0	4	4	4	5	4	6	10	13
Strain "D_4":								
++++	2	0	0	0	0	0	0	0
+++	2	1	0	0	0	0	0	0
++	1	2	0	0	0	0	0	0
+	0	2	3	0	0	0	0	0
±	0	0	1	3	0	0	0	0
0	0	1	2	5	5	5	5	5

[1] Tests on uninoculated rabbits (controls) were negative throughout.

4. *Technique of the test.* To 1 cc. of each dilution was added 0.5 cc. of bacterial suspension, and the mixture incubated for 24 hours (6 hours at room temperature, 23–25°C.; 18 hours, at 10°C.). A sample protocol (*table 2*) illustrates the results, where gradations in the amount of agglutination are shown as follows: ++++ denotes very

marked agglutination, i.e., the formation of large flocules; 0, at the other extreme, indicates absence of agglutination.

5. *Results.* Eighteen rabbits were studied. The findings for sera and salivas are shown in *tables 3 and 4.*

V. CONCLUSIONS

(1) Sera from fourteen of a total of eighteen rabbits, inoculated with dead B. acidophilus, showed agglutination to a greater or less degree.

TABLE 4

Total number of salivas showing agglutination in the dilutions, and to the extent, indicated[1]

EXTENT OF AGGLUTINATION	DILUTION OF SALIVA EMPLOYED							
	Undiluted	1–4	1–8	1–16	1–32	1–64	1–128	1–256
Strain "L"								
++	2	0	0	0	0	0	0	0
+	1	0	0	0	0	0	0	0
±	1	2	0	0	0	0	0	0
0	5	7	9	9	9	9	9	9
Strain "D_3"								
++	1	0	0	0	0	0	0	0
+	2	1	0	0	0	0	0	0
±	0	0	1	0	0	0	0	0
0	2	4	4	5	5	5	5	5

[1] Tests on uninoculated rabbits (controls) were negative throughout.

(2) Saliva from these rabbits bore agglutinins in 7 of 14 cases. The titre was much weaker than that of the sera, and the observed agglutination was very slight.

(3) Cross agglutinins for two different strains were present.

(4) Should the existing data for the belief that B. acidophilus is an etiological factor in dental caries be substantiated, the present experiments would appear to add some degree of experimental evidence in favor of attempts at vaccine prophylaxis and treatment.

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THE ORIGIN AND EVOLUTION OF THE HUMAN DENTITION

A Palæontological Review

BY

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